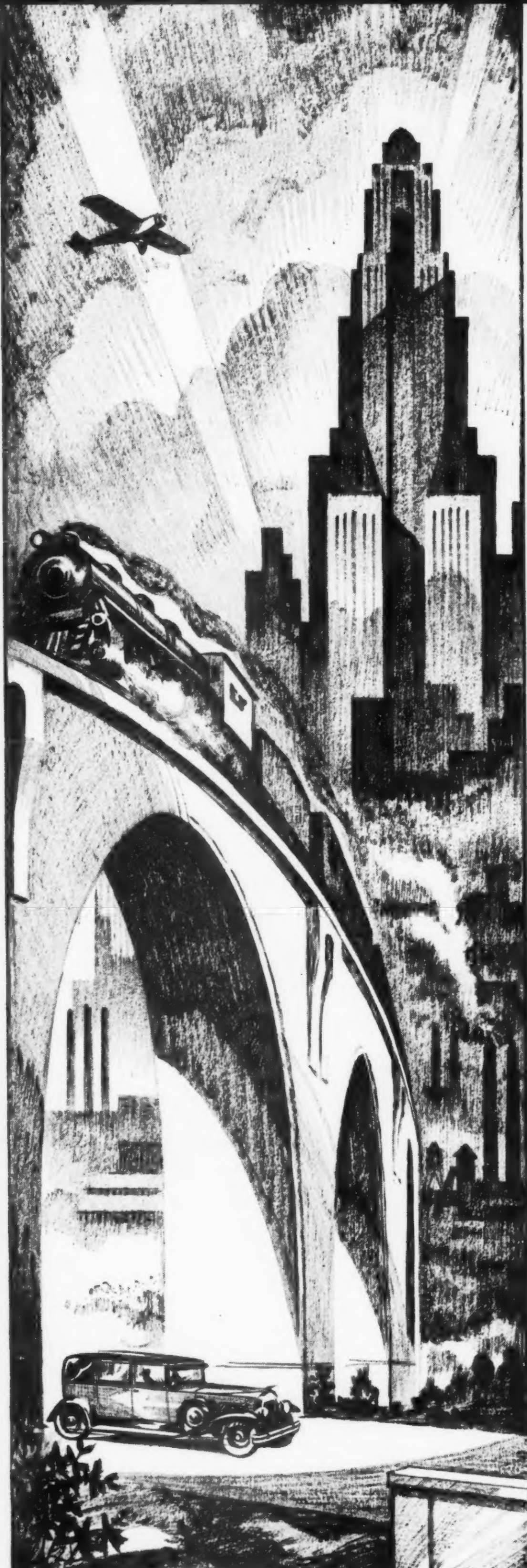
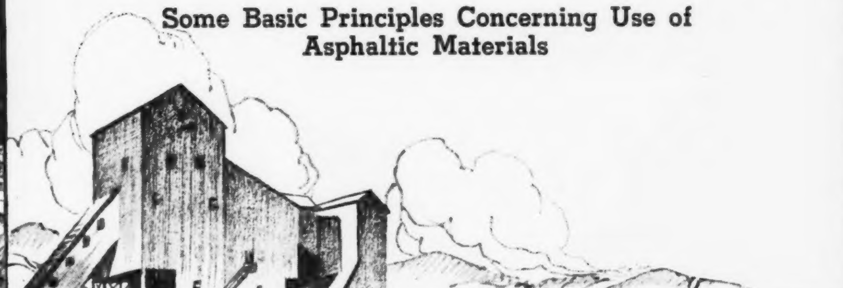


The CRUSHED STONE JOURNAL

PUBLISHED QUARTERLY

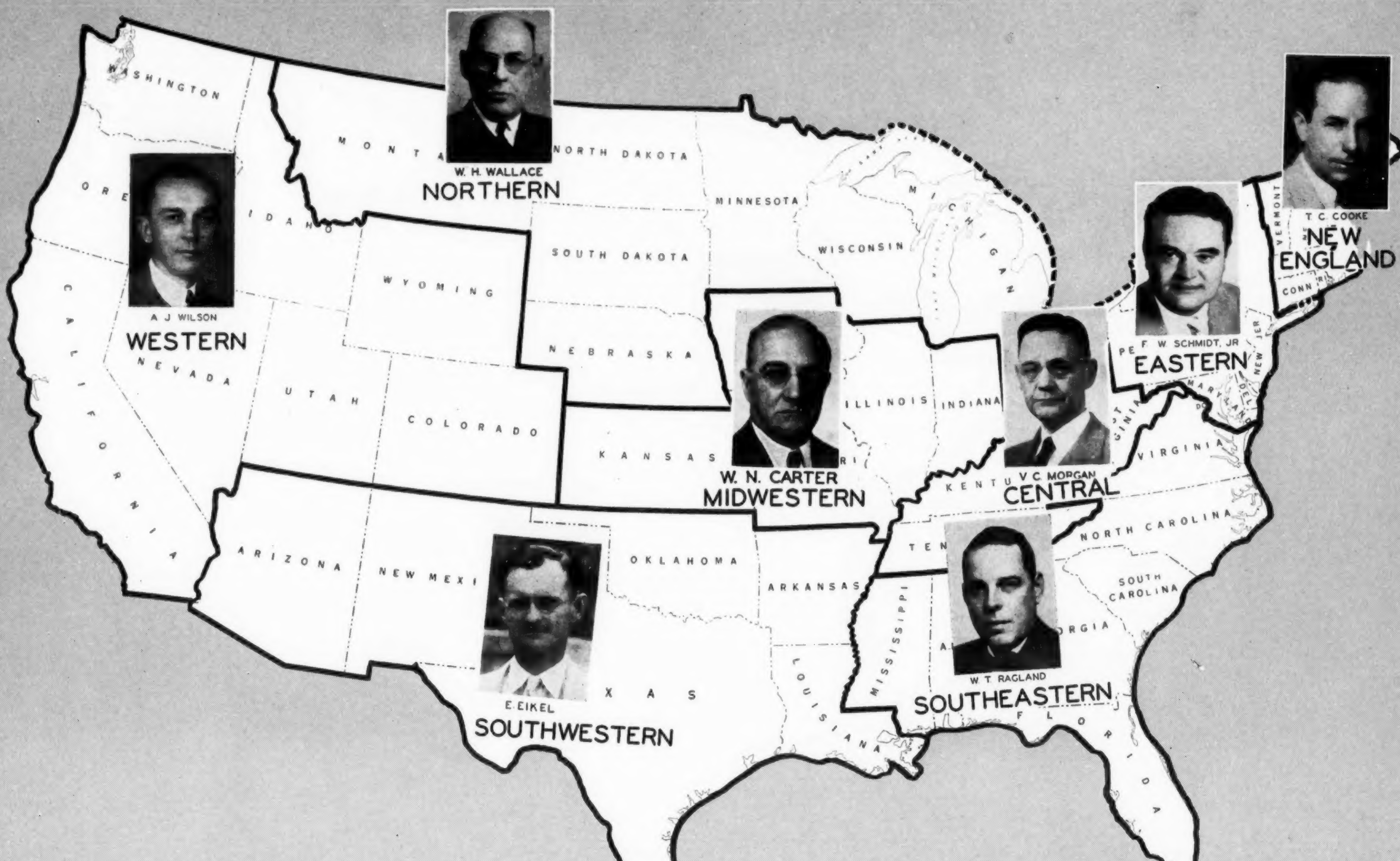
In This Issue



March · 1947

Official Publication
NATIONAL CRUSHED STONE ASSOCIATION

MAP SHOWING REGIONS AND REGIONAL VICE PRESIDENTS FOR 1947
NATIONAL CRUSHED STONE ASSOCIATION



The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

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G. A. AUSTIN
President

Consolidated Quarries Corp.,
Decatur, Georgia

•

Re-elected President
NATIONAL CRUSHED STONE ASSOCIATION
at its 30th Annual Convention,
Chicago, Ill.
January 27-29, 1947

S. P. MOORE
Concrete Materials and Construction Co.
Cedar Rapids, Iowa

•

Re-elected Chairman
AGRICULTURAL LIMESTONE DIVISION
at its 2nd Annual Convention
Chicago, Ill.
January 30-31, 1947

THE
CRUSHED STONE JOURNAL

WASHINGTON, D. C.

Vol. XXII No. 1 PUBLISHED QUARTERLY MARCH, 1947

30th Annual Convention at Chicago Establishes All High Attendance Record

FROM all sections of the country and in greatly augmented numbers crushed stone producers assembled at the Edgewater Beach Hotel, Chicago, during the week of January 27, 1947, to shatter all previous attendance records by a comfortable margin and establish the amazingly high registration of 651. Attendance at the 2nd Annual Convention of the Agricultural Limestone Division which immediately followed the NCSA meeting was likewise gratifyingly large with a registration of 270. Total attendance for both groups after eliminating overlap was 806. The Manufacturers' Division did itself proud with 165 present at its annual business meeting held at luncheon on Tuesday. The attractions of Chicago, coupled with the unusual setting provided by the Edgewater Beach Hotel must have proved especially appealing to the ladies for they were present in numbers greater than ever before and seemed to thoroughly enjoy the various special events which were provided for their entertainment.

The three-day meeting was characterized by an earnestness of purpose reflected by prompt attendance at the sessions and keen interest in the many talks given on a wide variety of subjects by authoritative speakers. The papers of outstanding interest and permanent value are being published in The Crushed Stone Journal or printed for distribution.

Election of Officers and Board of Directors

The annual election of officers and members of the Board of Directors was held on Tuesday morning January 28. Preliminary to submitting the formal report of the Nominating Committee, Russell Rarey, its Chairman, made the following highly appropriate comment: "Before presenting the formal report as Chairman of the Nominating Committee, it is perhaps in order to explain here that the action of the Nominating Committee in no way precludes the nomination of others from the floor, in fact, nominations of others are earnestly solicited if in your individual judgment there are other persons more capable of performing the job at hand than those named by the Nominating Committee. This is a democratic organization in that your interests are protected in that manner and they are further protected by the number selected to serve on the Nominating Committee and by the method of selection. Perhaps those of you who are not familiar with the procedure followed will be interested in learning that the Nominating Committee is chosen by the President and includes the past presidents of the Association, the presidents of local crushed stone associations, who are members of NCSA, and approximately twenty additional members are chosen with respect to geographical location of the production of the industry. The Committee so selected has deliberations and determines upon the candidates to be offered; but, again I repeat, in no instance does this mean that they are the only candidates. You are free and are requested to make such additional nominations as you deem advisable."

Chairman Rarey explained that of the total number, forty-eight, constituting the Board, fifteen were ex-officio, as follows: President, eight regional vice presidents, three each elected respectively by the Manufacturers' Division and the Agricultural Limestone Division to represent them on the National Board, leaving thirty-three directors to be elected by the Convention. Chairman Rarey then presented the report of the Nominating Committee in detail, re-

G. A. AUSTIN, *Chairman*,
Consolidated Quarries Corp.,
Decatur, Ga.

W. N. CARTER
National Stone Co.
Joliet, Ill.

OTHO M. GRAVES
General Crushed Stone
Co., Easton, Pa.

EXECUTIVE COMMITTEE

of the

NATIONAL CRUSHED STONE ASSOCIATION

elected by the Board of Directors at its meeting in Chicago, Ill., January 28, 1947

S. P. MOORE
Concrete Materials
and Construction Co.,
Cedar Rapids, Iowa,
Representing the Agricultural Limestone Division

J. B. TERBELL
American Manganese
Steel Division,
American Brake Shoe
Co. New York, N. Y.,
Representing the Manufacturers' Division

RUSSELL RAREY
Marble Cliff Quarries
Co., Columbus, Ohio

F. W. SCHMIDT, JR.
North Jersey Quarry
Co., Morristown, N. J.

STIRLING TOMKINS
New York Trap Rock
Corp., New York, N. Y.

W. F. WISE
Southwest Stone Co.,
Dallas, Texas

A. L. WORTHEN
New Haven Trap Rock
Co., New Haven,
Conn.

AMONG NEWLY ELECTED MEMBERS OF THE BOARD

BRUCE S. CAMPBELL
Harry T. Campbell Sons' Corp., Towson, Md.

H. C. KRAUSE
Columbia Quarry Co., St. Louis, Mo.

A. BATTLE RODES
Franklin Limestone Co., Nashville, Tenn.

W. S. WESTON, JR.
Weston & Brooker Co. Columbia, S. C.

sulting in the unanimous election of members of the Board as listed below. Newly elected members of the Board are Bruce S. Campbell, H. C. Krause and W. S. Weston, Jr. A. Battle Rodes was first elected to membership on the Board at its mid-year meeting in July 1946, replacing his father, H. E. Rodes, who was elected to honorary membership at that time.

Directors

Wm. M. Andrews, Union Limestone, Co., New Castle, Pa.
L. J. Boxley, Blue Ridge Stone Corp., Roanoke, Va.
H. H. Brandon, Melvin Stone Co., Melvin, Ohio
J. E. Bryan, Bryan Rock & Sand Co., Raleigh, N. C.
J. Reid Callanan, Callanan Road Improvement Co., South Bethlehem, N. Y.
Bruce S. Campbell, Harry T. Campbell Sons' Corp., Towson, Md.
A. J. Cayia, Inland Lime and Stone Co., Manistique, Mich.
H. N. Clark, Dolomite Products Co., Inc., Rochester, N. Y.
F. O. Earnshaw, Carbon Limestone Co., Youngstown, Ohio
Arthur F. Eggleston, John S. Lane & Son, Inc., Meriden, Conn.
Otho M. Graves, General Crushed Stone Co., Easton, Pa.
G. F. Hammerschmidt, Elmhurst-Chicago Stone Co., Elmhurst, Ill.
R. G. L. Harstone, Canada Crushed Stone Ltd., Hamilton, Ontario, Can.
J. L. Heimlich, LeRoy Lime and Crushed Stone Corp., LeRoy, N. Y.
R. P. Immel, American Limestone Co., Knoxville, Tenn.
N. E. Kelb, Cumberland Quarries, Inc., Indianapolis, Ind.
H. C. Krause, Columbia Quarry Co., St. Louis, Mo.
J. C. Lauber, Trap Rock Co., Minneapolis, Minn.
M. E. McLean, East St. Louis Stone Co., East St. Louis, Ill.
Paul M. Nauman, Dubuque Stone Products Co., Dubuque, Iowa
H. E. Rainer, Federal Crushed Stone Corp., Buffalo, N. Y.
Russell Rarey, Marble Cliff Quarries Co., Columbus, Ohio
J. A. Rigg, Acme Limestone Co., Fort Spring, West Virginia
A. Battle Rodes, Franklin Limestone Co., Inc., Nashville, Tenn.
W. R. Sanborn, Lehigh Stone Co., Kankakee, Ill.
James Savage, Buffalo Crushed Stone Corp., Buffalo, N. Y.
A. T. Smith, Rock Hill Quarries Co., St. Louis, Mo.
O. M. Stull, Liberty Limestone Corp., Buchanan, Va.
Stirling Tomkins, New York Trap Rock Corp., New York, N. Y.
W. S. Weston, Jr., Weston & Brooker Co., Columbia, S. C.
D. L. Williams, Virginian Limestone Corp., Ripplemead, Va.
W. F. Wise, Southwest Stone Co., Dallas, Texas
A. L. Worthen, New Haven Trap Rock Co., New Haven, Conn.

Regional Vice Presidents

In accord with the recommendations of the Nominating Committee the following were unanimously elected as Regional Vice Presidents for the regions indicated:

Eastern—F. W. SCHMIDT, JR.
New England—T. C. COOKE
Midwestern—W. N. CARTER
Southeastern—W. T. RAGLAND
Central—V. C. MORGAN
Northern—W. H. WALLACE
Western—A. J. WILSON
Southwestern—E. EIKEL

"Art" Austin Re-elected President

In concluding the report of the Nominating Committee, Chairman Rarey spoke as follows:

"The one remaining position to be considered by the Convention at this time is the office of President. One year ago Mr. Andrews offered the name of our present President to be executive officer for 1946. You saw fit to concur in the nomination made and the selection has proven an admirable one. President Austin has been capable and energetic. He has given freely of his time to his duties and he would make the selection of a successor rather difficult were it not for one thing: The Nominating Committee was of the unanimous opinion that the gentlemen should be nominated to succeed himself and I therefore take great pleasure in offering the name of Arthur Austin of Decatur, Georgia, as President for the ensuing year." Mr. Rarey then temporarily assumed the Chair and by a rising vote and enthusiastic applause Mr. Austin was unanimously re-elected.

JAMES SAVAGE
Buffalo Crushed Stone Corp.,
Buffalo, N. Y.,
Re-elected Treasurer

President Austin, in accepting office for another year, said: "I very much enjoyed my work over the past year. During the OPA hectic days I received encouragement from many of our members. It was most highly appreciated. I have enjoyed very close contact with our staff and I am looking forward to a continuation of that over the next year. I assure you I will do my best."

Representatives of the Manufacturers' Division and of the Agricultural Limestone Division on the National Board

In accord with the By-Laws, the Manufacturers' Division and the Agricultural Limestone Division are each authorized to designate two representatives as ex-officio members of the National Board in addition to their respective chairmen.

As a result of the election held at the business meeting of the Manufacturers' Division on Tuesday, January 28, J. B. Terbell was re-elected Chairman of the Division and R. C. Johnson and L. C. Mosley were designated to serve with him as ex-officio members of the National Board.

S. P. Moore was re-elected Chairman of the Agricultural Limestone Division at its annual business meeting on Friday, January 31, and thus became an ex-officio member of the National Board. In addition, the Agricultural Limestone Division Board of Directors, at its meeting on Friday, January 31, designated James Eells and A. Battle Rodes as its other two ex-officio members on the National Board.

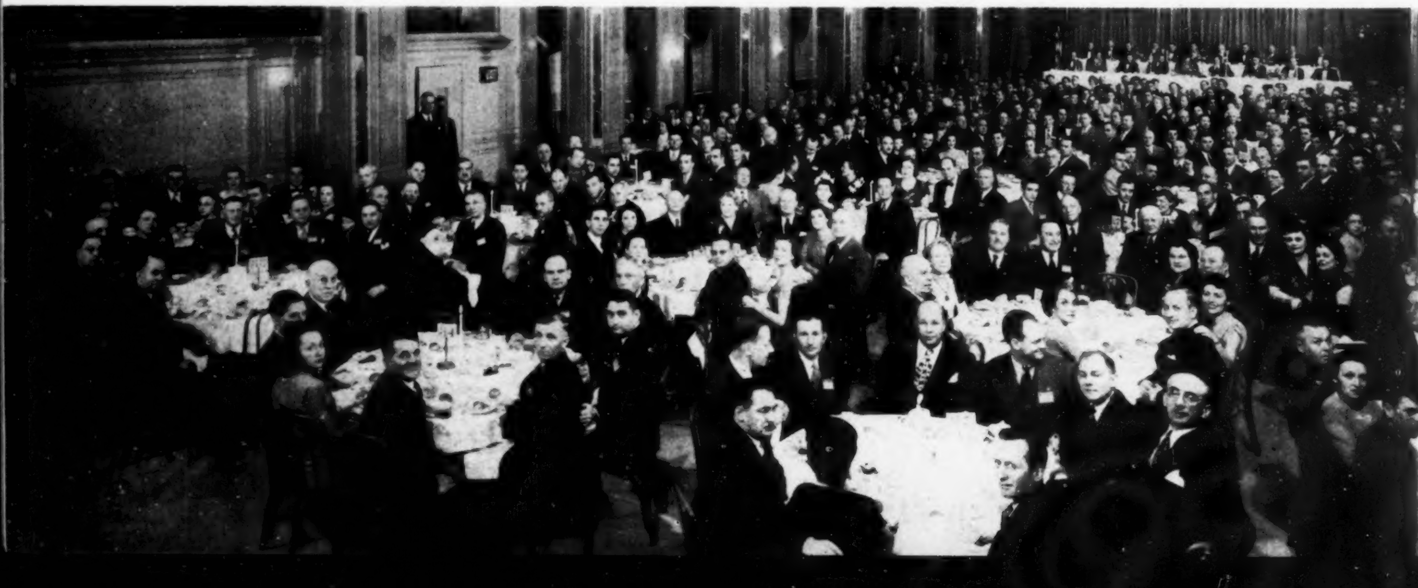
Elections by New Board

The newly elected Board of Directors met on Tuesday, January 28, and elected the following to the Executive Committee for the ensuing year:

W. N. CARTER
OTHO M. GRAVES
RUSSELL RAREY
F. W. SCHMIDT, JR.
STIRLING TOMKINS
W. F. WISE
A. L. WORTHEN

Ex-officio members of the Committee include: G. A. Austin, President of the Association; J. B. Terbell, Chairman of the Manufacturers' Division; and

30th Annual Banquet, National Crushed Stone Association and 2nd Annual Banquet, Agricultural Limestone Division Edgewater Beach Hotel, Chicago, Illinois, January 29, 1947



Manufacturers' Division, Annual Business Meeting Luncheon, Chicago, Ill., January 28, 1947

S. P. Moore, Chairman of the Agricultural Limestone Division.

In addition, James Savage was re-elected Treasurer; A. T. Goldbeck, Engineering Director; J. E. Gray, Field Engineer; and J. R. Boyd, Administrative Director and Secretary.

Also, the following were elected to honorary membership on the National Board:

A. J. Blair, Annapolis, Md.
John C. Gall, Washington, D. C.
John Rice, Easton, Pa.
H. E. Rodes, Nashville, Tenn.
Harold Williams, Boston, Mass.

Manufacturers' Division Holds Annual Election

At the annual business meeting of the Manufacturers' Division, held on Tuesday, January 28, 1947, with approximately 165 in attendance, J. B. Terbell, American Manganese Steel Division of The American Brake Shoe Company, New York City, was re-elected Chairman; also, the following were elected as Vice Chairmen and members of the Board of Directors:

Vice Chairmen

Cott Farrell	J. Craig McLanahan	C. H. Roberts
R. C. Johnson	L. C. Mosley	J. A. Trainor

Board of Directors

J. B. Terbell, *Chairman*, American Manganese Steel Division, The American Brake Shoe Co., New York, N. Y.

E. C. Anderson, Kensington Steel Co., Chicago, Ill.

A. E. Conover, Robins Conveyors, Inc., Passaic, N. J.

Irving Diester, Diester Machine Co., Fort Wayne, Ind.

M. A. Eiben, Northern Blower Co., Cleveland, Ohio.

S. S. Ellsworth, Ensign-Bickford Co., Simsbury, Conn.

Cott Farrell, Easton Car & Construction Co., Easton, Pa.

R. F. Feind, Allis-Chalmers Mfg. Co., Milwaukee, Wis.

J. Harper Fulkerson, Cross Engineering Co., Carbondale, Pa.

E. J. Goes, Koehring Co., Milwaukee, Wis.

E. M. Heuston, Bucyrus-Erie Co., South Milwaukee, Wis.

C. S. Huntington, Link-Belt Co., Chicago, Ill.

John M. Jeffries, Atlas Powder Co., Wilmington, Del.

R. C. Johnson, Simplicity Engineering Co., Durand, Mich.

W. W. King, W. S. Tyler Co., Baltimore, Md.

Kenneth Lindsay, Iowa Mfg. Co., Cedar Rapids, Iowa

B. R. Maloney, E. I. Du Pont de Nemours & Co., New York, N. Y.

J. Craig McLanahan, McLanahan & Stone Corp., Hollidaysburg, Pa.

L. C. Mosley, Marion Power Shovel Co., Marion, Ohio

R. M. Murdock, The Frog, Switch & Mfg. Co., New York, N. Y.

Milo A. Nice, Hercules Powder Co., Wilmington, Del.

F. O. Reedy, Kennedy-Van Saun Mfg. & Eng. Corp., New York, N. Y.

C. H. Roberts, Traylor Eng. & Mfg. Co., Allentown, Pa.

Bruce G. Shotton, Hendrick Mfg. Co., Pittsburgh, Pa.

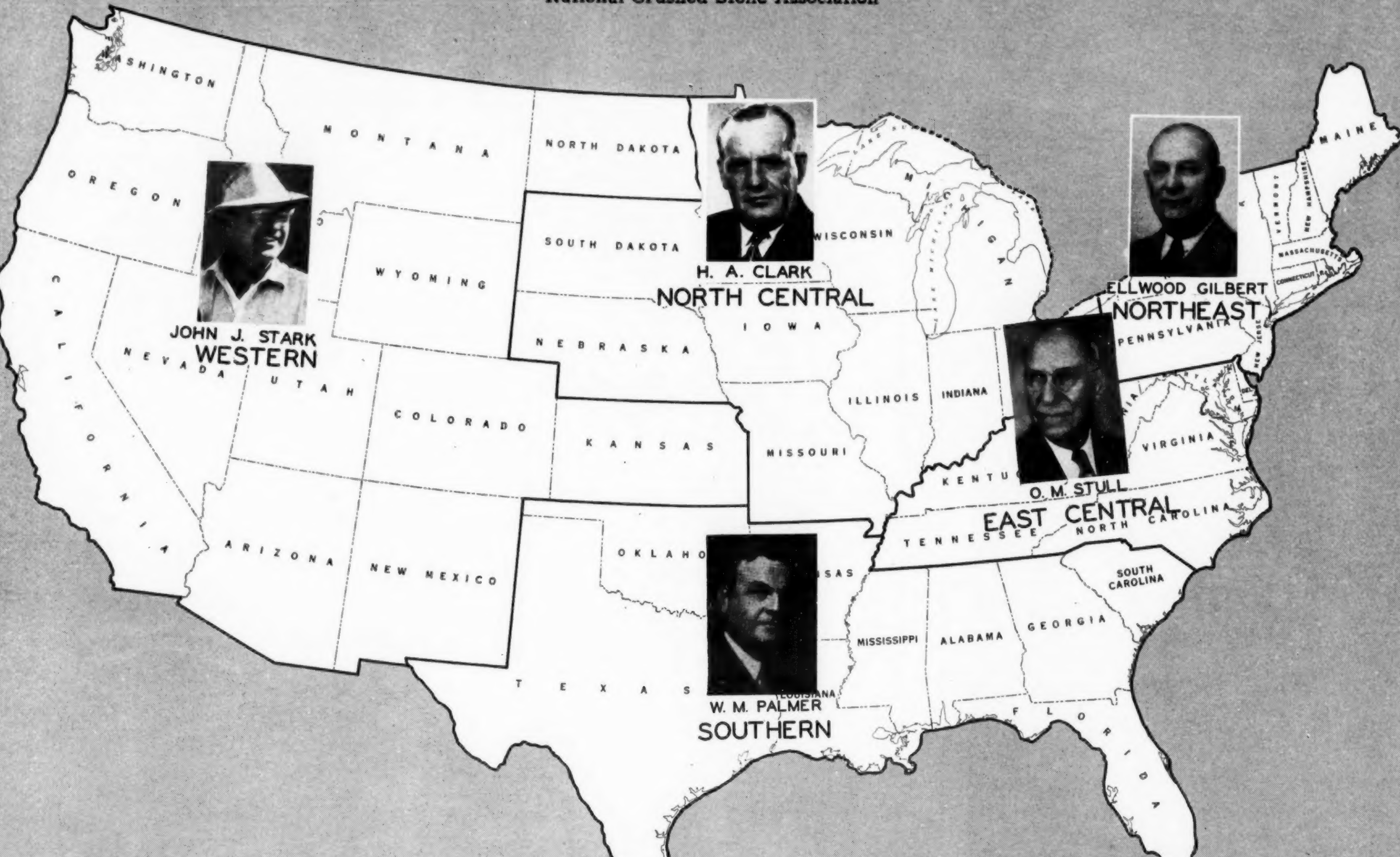
J. A. Trainor, Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

R. E. Wiley, American Cyanamid Co., New York, N. Y.

Roy Wills, Lima Locomotive Works, Lima, Ohio

W. A. Wirene, General Electric Co., Schenectady, N. Y.

MAP SHOWING REGIONS AND REGIONAL VICE CHAIRMEN FOR 1947
AGRICULTURAL LIMESTONE DIVISION
National Crushed Stone Association



Agricultural Limestone Division Holds Successful Second Annual Convention

THE rapidly growing interest of agricultural limestone producers in the cooperative solution of problems mutual to them was well exemplified in the large attendance, from all sections of the country, at the Second Annual Convention of the Agricultural Limestone Division held on January 30 and 31, 1947, at the Edgewater Beach Hotel in Chicago, Illinois.

The Convention was opened with a Greeting Luncheon attended by over one hundred and fifty persons. Wayne Darrow, publisher of the Washington Newsletter, was the featured speaker at the Luncheon. He spoke in a most interesting manner on "Back of the Farm Scenes in Washington," relating the philosophies that now are prevalent in the Nation's Capital and the background stimuli that often result in things being done in Washington as they are.

Fifth of Conservaticn Money Spent for Limestone

Grant Thompson, Assistant Director of the Field Service Branch, Production and Marketing Administration, said that at present one-fifth of all conservation money is being used to help pay for limestone and all other practices get the remaining four-fifths. He called attention to the fact that the President had recommended to Congress a cut of $100,000,000 in the appropriation for the 1948 Agricultural Conservation Program. He stated that should such a cut be made it will be necessary for this industry to place much more emphasis on the selling of limestone to farmers. He welcomed the close association that has existed during the past year between the U. S. Department of Agriculture and the industry and stated that the future will make such cooperation even more necessary.

Dave Davison, Director of the Field Service Branch, broke away from a busy schedule in Washington to attend the opening session of the Convention. He, likewise, offered every possible cooperation and complimented the industry on the excellent job it has done.

Erosion, Crop Quality and Principles of Liming Discussed

During the Friday morning session and at luncheon three talks of specific interest to agricultural limestone producers were heard. Dr. Grover F. Brown spoke on erosion. He illustrated by word and by motion pictures how the cutting and transporting effect of rain drops must be controlled if our fertile topsoils are to be saved. The answer lies in vegetative covers—preferably dense grass or legume growths that hold the soil in place. Nearly everywhere a first requirement to attain such covers is the application of limestone.

Another talk of importance was the effect of soil treatment on the quality of food and feed crops. Kenneth C. Beeson of the U. S. Plant, Soil and Nutrition Laboratory stated that although crop quality can be improved by fertilizing and liming, the inferences in some of the popular magazine articles were exaggerated. It was his opinion that the subject requires much more study.

Professor B. J. Firkins of Ames, Iowa, presented a most interesting discussion on "Factors Governing the Efficient Use of Limestone." He emphasized that the welfare of farmers in the humid areas is dependent upon a "sweet land" system of agriculture involving the growing of pastures and legume crops. This means the use of more and more limestone and it was his opinion that the future for the industry should be a bright one.

Food or More War

Dr. George D. Scarseth held the audience tense for an hour during the Friday afternoon session as he developed his subject, "Food or Atom Bombs—It's Up to Us." He warned that wars usually result when the have-nots get dissatisfied with their plight. He uged an economy of abundance and that high production be attained on fewer acres of properly cared for soil.

Election of Officers and Board of Directors

At the annual business meeting the Nominating Committee, of which P. E. Heim was chairman, submitted the following nominees for chairman, five regional vice chairmen and twenty-nine directors, all of whom were elected unanimously.

H. A. CLARK
Consumers Co.,
Chicago, Ill.
North Central Region

S. P. MOORE, *Chairman*
Concrete Materials
and Construction Co.,
Cedar, Rapids,
Iowa

PAUL I. DETWILER
New Enterprise Stone
and Lime Co., New
Enterprise, Pa.,
Northeast Region

EARLE L. DINGLE
Harry T. Campbell
Sons' Corp.,
Towson, Md.
East Central Region

EXECUTIVE COMMITTEE

of the
AGRICULTURAL LIMESTONE DIVISION
of the National Crushed Stone Association
elected by the Board of Directors at its meeting in
Chicago, Ill., January 31, 1947

OTHO M. GRAVES
General Crushed Stone
Co., Easton, Pa.,
Representing the National Crushed Stone Association

L. W. HAYES
Kansas City, Mo.
North Central Region

P. E. HEIM
Carbon Limestone Co.,
Youngstown, Ohio,
North Central Region

H. C. KRAUSE
Columbia Quarry Co.,
St. Louis, Mo.
North Central Region

R. T. WILLINGHAM
Willingham-Little
Stone Co., Atlanta, Ga.,
Southern Region

Board of Directors

S. P. Moore, *Chairman,* Concrete Materials & Construction Co., Cedar Rapids, Iowa

NORTHEAST REGION

Ellwood Gilbert, *Vice Chairman,* New Castle Lime and Stone Co., New Castle, Pa.
H. E. Battin, Jr., Callanan Road Improvement Co., South Bethlehem, New York
Paul I. Detwiler, New Enterprise Stone & Lime Co., New Enterprise, Pa.
R. H. Nolan, Nolan Stone Co., Inc., Rome, New York

EAST CENTRAL REGION

O. M. Stull, *Vice Chairman,* Liberty Limestone Corp., Buchanan, Va.
Earle L. Dingle, Harry T. Campbell Sons' Corp., Towson, Md.
S. B. Downing, Jr., Central Rock Co., Lexington, Ky.
R. P. Immel, American Limestone Co., Knoxville, Ky.
A. W. McThenia, Acme Limestone Co., Fort Spring, W. Va.
W. T. Ragland, Superior Stone Co., Raleigh, N. C.
A. Battle Rodes, Franklin Limestone Co., Inc., Nashville, Tenn.

NORTH CENTRAL REGION

H. A. Clark, *Vice Chairman,* Consumers Co., Chicago, Ill.
W. L. Bryan, Bryan Construction Co., Northfield, Minn.
G. B. Clark, Midwest Limestone Co., Gilmore City, Iowa
W. D. Dillon, Dillon, Sharpe and Co., Columbus Junction, Iowa

AMONG THOSE NEWLY ELECTED TO BOARD OF DIRECTORS

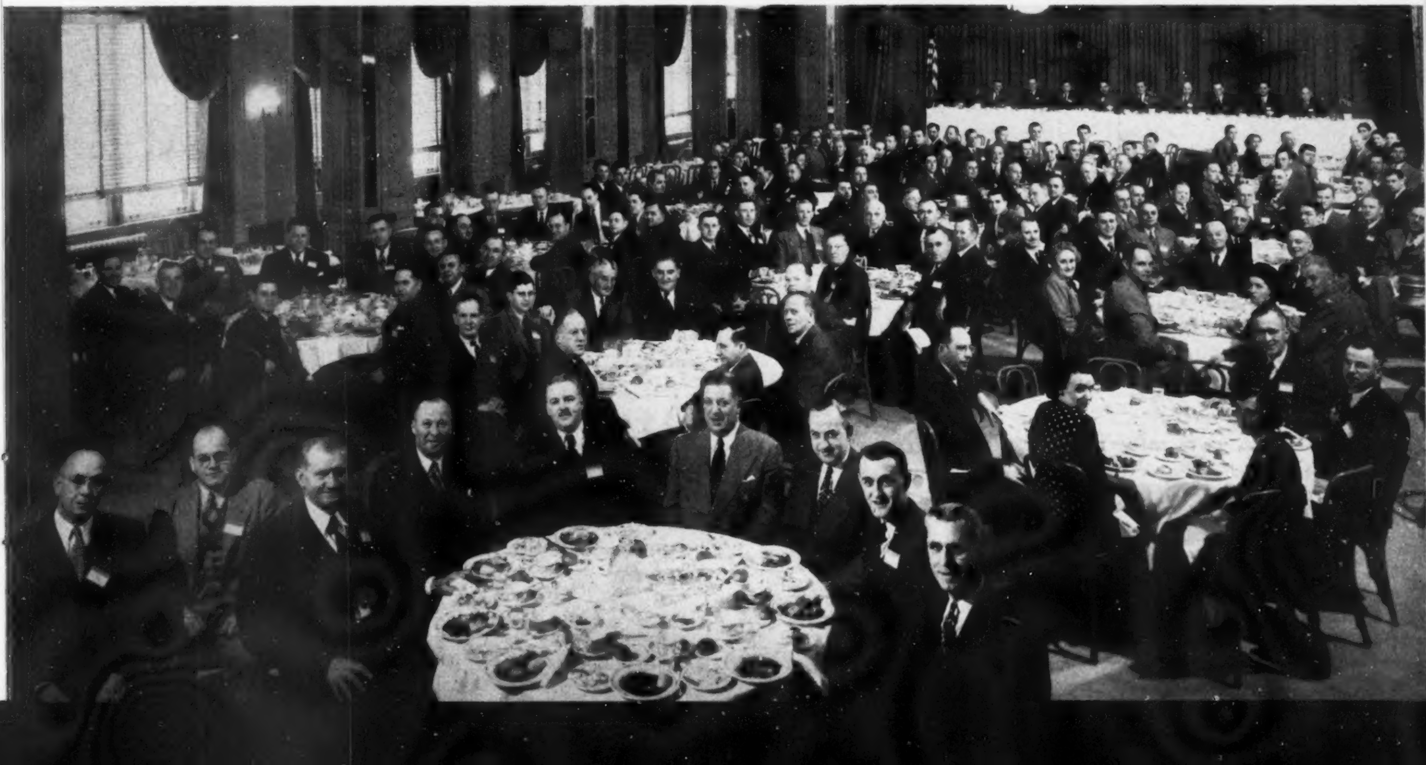
Agricultural Limestone Division

JOHN H. RIDDLE
Riddle Quarries, Inc.
Marion, Kansas

R. H. NOLAN
Nolan Corporation
Rome, N. Y.

James Eells, Basic Dolomite, Inc., Cleveland, Ohio
A. E. Hanshaw, Lehigh Stone Co., Kankakee, Illinois
A. K. Hausmann, Kelley Island Lime and Transport Co., Cleveland, Ohio
L. W. Hayes, Kansas City, Mo.
P. E. Heim, Carbon Limestone Co., Youngstown, Ohio
W. E. Hewitt, East St. Louis Stone Co., East St. Louis, Ill.
H. C. Krause, Columbia Quarry Co., St. Louis, Mo.
Ed. J. Leary, Ed. J. Leary Construction Co., River Falls, Wis.
S. J. Marks, Material Service Corporation, Chicago, Ill.
F. W. Mumma, Columbia Quarry Co., St. Louis, Mo.
Paul M. Nauman, Dubuque Stone Products Co., Dubuque, Iowa
Norbert Neuheisel, Neuheisel Lime Works, Eau Claire, Wis.
R. M. Seifried, National Lime and Stone Co., Findlay, Ohio

Greeting Luncheon, Second Annual Convention, Agricultural Limestone Division, Chicago, Ill., January 30, 1947



SOUTHERN REGION

W. M. Palmer, *Vice Chairman,* Dolomite Products, Inc., Ocala, Fla.
E. V. Scott, Southwest Stone Co., Dallas, Texas
C. M. Sims, Campbell Limestone Co., Gaffney, South Carolina
R. T. Willingham, Willingham-Little Stone Co., Atlanta, Ga.

WESTERN REGION

John J. Stark, *Vice Chairman,* Girard, Kansas
John H. Riddle, Riddle Quarries, Inc., Marion, Kansas

REPRESENTING THE NATIONAL CRUSHED STONE ASSOCIATION

Otho M. Graves, General Crushed Stone Co., Easton, Pa.

New Board Meets; Elects Executive Committee; Changes Rate of Dues

At the close of the business meeting, late Friday afternoon the newly elected Board of Directors held its first meeting, at which time the following were elected to the Executive Committee for the ensuing year:

H. A. CLARK	L. W. HAYES
PAUL I. DETWILER	P. E. HEIM
EARLE L. DINGLE	H. C. KRAUSE
R. T. WILLINGHAM	

Also included on the Executive Committee, as ex-officio members, are S. P. Moore, Chairman of the Division, and Otho M. Graves, representing the National Crushed Stone Association. As permitted by the By-Laws, the Board elected James Eells and A. Battle Rodes to serve with S. P. Moore on the Board of Directors of the National Crushed Stone Association. J. R. Boyd was re-elected Secretary-Treasurer.

One of the most important actions taken by the new Board was to increase the rate of dues in the Division from $1.25 per 1,000 tons annually to $2.00 per 1,000 tons annually. This action was taken to assure the Division sufficient funds to operate successfully during 1947. It will permit an expanded promotional program and an effective campaign to fight any reduction in funds for conservation payments, for the calendar year 1948, including the use of limestone.

The Human Factor in Safety Effort

AN EXCELLENT article dealing with the human factor in accident prevention entitled, "Who Are Your Accident-Prones and Why?" by W. F. Hubbard, has recently come to our attention. It appeared in the February 1947 issue of *Safety Engineering* and can be briefly summarized as follows:

A long program of investigations of accidents resulted in bringing greater emphasis on the human factor in the safety effort. A survey disclosed the need of additional guards, but scarcely one accident could be charged against those hazards. The causes lay not in the machine methods, or training, but in the man himself. This idea led to a study, not of "When, Where,, and How" but of "Who, How Often and Why." Four questions were set up, and largely answered by the survey: (1) Are workers prone to a certain type of accident, independent of the type of exposure in their department? The accident pattern is seldom sufficiently definite to rely on, but there are certain types of accidents which repeat in an individual, foreign bodies in the eye, strains and dermatitis were the most usual in this company. (2) Does the number of accidents which a man has in one period foretell the number he will have in the next? No. Some men are consistently above or below the average, but how much above or below varies greatly. (3) Can a serious (compensable or lost time) accident be foretold by the type or number of accidents in a given period? This question gave the real lead. It was found that about 10 per cent of the men could be selected in one month that would account for about 50 per cent of the lost time or medical expenses the next month. Thus each foreman had only one or two men to watch closely. (4) If any one of the above is true, can a man's difficulty or proneness to accidents, be located and corrected so as to prevent future accidents? Five general types of accident-prone workers were found: the fast moving, the clumsy, the worried, the new to the job, and the falsely brave. The first group can be helped by the foreman and made slower and surer; the clumsy should be assigned to safer jobs; the worries of the third group can be located, talked over, and often solved; experience is the cure for the fourth, but generally not much can be done for the fifth, because they refuse to learn. Simple directions are given for computing statistics to determine the accident-prone.

The Construction Outlook[1]

By JAMES W. FOLLIN
Assistant Administrator
Federal Works Agency
Washington, D. C.

TO me, this occasion has some of the flavor of Old Home Week. It is good to get away from Bagdad on the Potomac occasionally and meet the folks out through the country who, in one way or another, are responsible for doing the nation's construction work.

In the Federal Works Agency we are responsible for decisions having to do with highway construction, through the Public Roads Administration; with the construction of Federal buildings of various kinds, through the Public Buildings Administration; and with assistance to local communities in the advance planning of public works, through the Bureau of Community Facilities. But at times what we do in Washington seems somewhat detached from actuality, and it is good to be able to go out occasionally and see what our district engineers, the contractors, and the material supply people have done to give form and substance to our concepts of better buildings, better roads, and better plans for community facilities.

Through my work in the Producers' Council over many years I became acquainted with many members of this association, and today I feel that I am among old friends.

1947 Construction 30% Above 1946

I come to you as the bearer of good tidings. I may have to qualify that a little later on, for you know there is nothing more useful to a Washington bureaucrat than a boxful of qualifications on his desk to be liberally sprinkled over his commitments. I am not the seventh son of a seventh son, my ability to foretell the future may not be much better than yours; or, if it is better, it is only because our department of research is constantly busy assembling data in an effort to ascertain the direction in which the wind is blowing. And the data indicate that this year of 1947 will be a very satisfactory one from the standpoint of the construction industry.

When I say that it looks to us as though the total value of new construction this year will be in the vicinity of 13 billion, 300 million dollars, I must in all fairness give you the assumptions on which that estimate is based, an estimate that indicates a 30% increase over 1946.

First of all, we assume that the world isn't going to come to an end this year and that there will be no general business recession. We also assume that there will be no widespread or prolonged strikes holding up the delivery of needed materials. Our estimate is made in terms of 1946 prices, since, of course, we cannot chart in advance possible future price movements.

Costs May Go Up—Prices Down

There may be some increases in wages and some increases in building material prices. But on the other hand we look for a smoother flow of materials and better labor productivity. Thus we might get no increase, or even an actual decline, in costs per unit of construction despite some wage and price increases.

Such economies as are related to increased productivity and a better flow of materials would seem to be necessary if construction is not to price itself out of the market.

Channeling of some raw materials to building product manufacturers will continue through the first quarter of this year. Continued emphasis on production of certain critical products is necessary if building construction is not to be unduly restricted, and the demand for non-critical items reduced below current supply.

The estimate of $13.3 billion of new construction is predicated on the material and labor supply, the demand for various types of construction and, most importantly, the restriction, for the present, upon non-residential building construction. Restriction stems from the policy of favoring residential construction. It is exercised under the authority of the 2nd War Powers Act, but it may be exercised under the Patman Act—the Veterans' Emergency Housing Act—which extends to December 31, 1947. Ample material supply is therefore being reserved for the maximum possible housing construction by restrict-

[1] Presented at the 30th Annual Convention, National Crushed Stone Association, Edgewater Beach Hotel, Chicago, Ill., January 27-29, 1947.

ing other building which competes for critical materials. As to housing it seems wholly possible that there may be more than a million starts in 1947, and nearly that many completions representing construction of about 5.8 billion dollars. This is at a rate 50% above 1946. All non-residential construction thus figures at 7.5 billion dollars, the two sums together totalling the expected volume of 13.3 for all new construction.

Most Construction Is Not Restricted

Contrary to general misunderstanding not all of this non-residential construction is controlled by order VHP-1. Engineering construction, such as streets and highways, dams, reclamation, river and harbor work, railroads, communication facilities and the like, water and sewer lines, and water supply and sewage treatment projects are exempt from the control order except for buildings or structures accessory to such projects.

Military projects and veterans' hospital construction, and exempted work in the public works and public utility fields is estimated for 1947 at a total of $3,300,000,000. Farm construction for 1947 is estimated at $500,000,000 and non-residential building construction at $3,700,000,000, about the same rate as in 1946. Included in this last figure are private construction (industrial and commercial) and public construction (educational, institutional, and other public buildings). If the material supply improves, or if housing does not develop to the extent indicated, then it may be possible to increase non-residential building construction.

The amount of non-residential building construction permitted under VHP-1 was held during the last half of 1946 to a dollar volume of 35 million a week for the country as a whole. In the Office of Temporary Controls we recently found it possible to increase the weekly permissible volume to 50 million a week. Further relaxation is dependent on developments already mentioned.

Public Construction Up—But Still Not Adequate

As to public construction, the outlook can hardly be characterized as bright in view of the accumulated needs. In this category we can expect a little over three billion dollars worth of work, both engineering and building construction—again, in terms of 1946 prices. That's about three-quarters of a billion dollars more than we got in 1946 but not enough to begin to compensate for the public construction postponed during the war and still further deferred.

Public agencies are continuing to postpone projects that might compete with housing for labor and materials. That reflects a fine, patriotic attitude on the part of public officials, but probably current high prices are even more persuasive in bringing about the deferment of public works not vitally needed for community health and security. Public bodies as a rule operate under very rigid budgetary limitations.

When contract bids run considerably in excess of cost estimates you either have to reject them out of hand and postpone the proposed improvement awhile longer, scale down the scope of the project to fit the funds available, or you have to scrabble around and try to find some more money. The latter alternative is not especially attractive because it usually involves returning to the voters with a request for approval of another bond issue. And it is more likely that a project will be deferred than that it will be scaled down to a point where it will fail to serve satisfactorily present and prospective future need.

Let's examine some of the particular items that go to make up this estimated total of a three-billion dollar investment in public works in 1947. Let's start with highways, in which I know you have a particular interest.

Highway Program Increasing But Not To Capacity

We expect the total highway investment this year to run around a billion, 300 million dollars, of which 925 million will be in the form of State and local contributions, and 375 million in Federal-aid funds. That Federal contribution is considerably less than was expected, for you will recall that the Federal-aid Highway Act of 1944 authorized a Federal contribution of 500 million a year for each of the first three postwar years. That sum, to be matched equally by the States, would have given us a total investment of a billion dollars a year in Federal-aid highways alone.

Where highways are concerned high costs seem to be particularly effective in slowing operations. Reports from the field indicate that many bids are being rejected for that reason, rather than from any desire to accumulate a backlog of work which, undertaken later, may be effective in ameliorating a threatened depression.

For five years heavy wartime traffic pounded large sections of the highway system to pieces and only a

minimum amount of repair and maintenance work could be done. Not only must the delayed repairs be made as soon as possible, but a large part of the whole national network must be rebuilt and brought up to modern standards.

The 1920's were a decade of feverish road building, which in turn facilitated a phenomenal expansion of automobile manufacturing. But thousands of miles of those roads are now virtually obsolete. The people who had to find the money to pay for them—township, county, and State officials—were primarily interested in getting as much mileage for their money as possible and did not hesitate to sacrifice engineering refinements to distance. The slogan was "Get the farmer out of the mud."

Roads were built to meet then-existing needs. Vehicles were relatively light in weight and a speed of 30 miles an hour was usually considered excessive. To provide safe four and six-lane highways capable of moving today's heavy traffic at today's speeds will take many years and many billions of dollars. But the job must be done.

More Airports and Other Items

As to airports, you are aware that the last Congress authorized a program of Federal aid to the States and communities for airport building. Getting the program into operation has been delayed by controversy over the rules and regulations that are to govern it. It looks to us as though about 50 million dollars would be the year's total investment in these projects, of which half will be Federal money and half State and local. The figure in this category in 1946 was only 12 million dollars.

The total Federal investment in public works such as flood control, irrigation, reclamation and river and harbor improvements, will probably be around 300 million this year.

Of State and local work, the greater volume will be in the form of schools, sewer and water improvements and extensions, which will be dictated by the necessities of new housing.

The Veterans' hospital program promises to run around 175 million dollars. Contracts are now beginning to be let in volume.

I do not wish to leave you with the impression that no more bottlenecks remain. Some still persist and for that reason the estimates I have given are at least optimistic—but I think not unreasonably so.

So much for estimates. For the more distant future the outlook is decidedly encouraging. A tremendous amount of public work badly needs doing because of the necessity during the war of postponing all construction not vitally essential to the war effort. If the investment in public works had continued during the last five years at no more than the rate reached in 1939, the country today would be some 14 billion dollars richer in terms of new schools, hospitals, water works and sewer systems, and other facilities needed to provide the necessary amenities of life and to meet the requirements of an increasing population. But we didn't get 14 billion dollars worth of public work.

The total cost of the war public works projects built by the Federal Works Agency under the Lanham Act was less than half a billion, and I suspect that was by far the greater part of all money spent on local public works.

Long-Range Outlook Is Encouraging

The outlook is also good in the overall construction market. Considerable time will be required to satisfy the deferred demands for private construction and to fulfill the new requirements of increased population and expansion of industry and business. Any one of us could point out the recognized needs in particular fields, commercial, housing, educational and others, but it seems more pertinent to examine a phase of the overall construction problem which has been receiving increased attention in recent years. I refer to the use of construction as a stabilizing influence on national income and employment.

Unquestionably there is a much clearer understanding of this subject now than formerly. Construction people learned in the 1930's that construction could not, of itself, provide employment to replace major reductions in industrial production or in the service trades. The Public Works Construction Advisory Committee to the Federal Works Agency set forth the situation succinctly when it stated that construction represented about 12 percent of the national income, and public works construction only one-third of this total, or only about 4 percent of the national income. Obviously, the tail cannot wag the dog.

The 1930 depression indicated that income from the production of goods and from services could quickly fall off by the tens of billions of dollars and construction obviously could not practically be increased in any such amount.

Perhaps a more important question is whether

construction can be accelerated as signs appear of declining business activity and so forestall that decline. Actually the question is whether public works construction, which is controlled by public authorities, can be so timed as to exert the required influence.

Economists Agree Public Works Not Foremost Depression Stopper

Some interesting observations on this subject are contained in the Economic Report of the President transmitted to the Congress January 8. That report was predicated on the advice of the Council of Economic Advisers established under the Employment Act of 1946. The President's report discusses the combating of economic fluctuations. It admits that public works expenditures are large and obviously have a considerable effect upon the whole economy.

Further, it states that many public works projects are not related to the daily problems of business operations or to daily needs of consumers and are, therefore, subject to adjustment in their time of commencement and their rate of progress. This fact, the report states, has led to over-emphasis upon the prospects of stabilizing the whole economy through the *bold* use of public works. However, the report concludes that public works cannot accomplish as much toward stabilization as some have supposed and that all useful devices need to be thought through in advance and blended into a consistent national program.

It is a distinct relief to have assurance from top levels that construction cannot do the impossible, and it permits us to concentrate our discussion to the timing of public works to afford the greatest good to the construction industry, with an indirect assistance to the whole economy.

Economists Favor Stabilization of Public Works Volume

The President's report further suggests that instead of regarding public works as the first and foremost device to revive a sagging economy, we should attempt to stabilize public works construction according to our long-term needs. This confirms the judgment of many construction people, especially in the highway field, who have advocated the regularization of public works expenditures at all levels of governmental activity in order to offer assurance of a demand for capital, and a steady market for materials, equipment, contractual services and labor.

The report emphasizes that such a policy by no means forestalls the expansion of public works as a sustaining factor if recessions or depressions should unfortunately develop despite the best efforts to avoid them. The very procedure necessary for long-term regularized expenditure will pave the way for more effective emergency use than in the past, the report concludes.

Why Not Stabilize Private and Public Construction Together?

What seems to some of us to be principally missing from this economic report is a consideration of the stabilization of the operations of both private and public construction, rather than of public works alone. The Public Works Construction Advisory Committee, previously referred to, while disavowing the practicability of using construction to equalize fluctuations in the general economy, suggested the possibility of using public works construction to help stabilize the operations of the entire construction industry.

In other words, if through that means the construction industry could so operate as to take care of its full quota of employment during recessions or depressions, it would not add to the unemployment created by other sectors of the economy. To the extent that its operations might be increased during such times, however slightly, construction operations would further aid the general economy. During the depression of the '30's, the total construction volume, although augmented by emergency public works programs, did not afford total employment equal to that in the construction industry in the 1920's. The depression hit construction harder than it did everything else.

This is not a simple problem, by any means. All public works construction cannot be postponed until there is a decline in private construction. High costs and the general inflexibility of public appropriations for particular projects, in such a period as the present, will operate to delay even many essential projects.

As a general rule, the public will receive greater construction value under the lower prices usually accompanying a serious decline in private construction, and postponement of deferrable projects to such a time is in the public interest. However, the most essential public projects must proceed even when private construction demands are active.

Furthermore, there is the necessity for carrying

out major programs, such as highways, on a long-term basis and of maintaining an optimum or desirable volume of work from the standpoint of maintaining a sufficient supply of materials and of contractual services.

This optimum volume should be susceptible of reasonable expansion when emphasis must be laid upon public construction because of decreased private construction demand.

Different Fields of Construction Offer Differing Stabilization Possibilities

Contrary to belief in uninformed quarters, construction firms cannot willy-nilly transfer their operations from one type of construction to another. There is specialization among construction firms as in other lines of business. The most obvious separation is that between construction and engineering construction, although within these two general classes some flexibility is possible.

By and large, engineering construction is actuated by governmental agencies and hence is principally operative in the public works field. On the other hand, building construction is more largely for private account and construction firms can quite readily switch from private to public building projects. Because of these conditions, a separate policy as to timing construction should be developed for each major type of construction.

Further, as a guiding principle, there might be developed for each major type of construction: first, the desirable or optimum rate of construction to fulfill long-range needs; second, a minimum rate representing the volume which must be maintained to supply essential non-deferrable needs, even in periods of competition from other types of construction; and third, a maximum rate representing such increase over the optimum or long-range rate at which that category of construction could operate in periods when it should assume a greater share of employment.

As an illustration, it is evident that the optimum, minimum and maximum construction rates agreed upon in the case of highways would be quite different from those agreed upon in the public buildings field. The minimum and maximum rates in highway building might vary but little from the optimum rate. On the other hand, the minimum rate on public buildings might be almost zero, as it is today, and the maximum rate extremely high during a period of depression.

Accordingly, public buildings would provide the flexibility, or the required workload for building contractors who in normal times would concentrate on private building construction. Obviously, it is impractical to apply the same rules on timing of projects to different categories of construction, and a suitable policy must be developed for each such category.

Will Private and Public Capital Support Stabilization?

The workload for the construction industry in the future must be considered as a gradually expanding volume to allow for increase in population and growth in industry and business and for an increasing standard of living. On this basis, the consideration is how, through the decisions of public authorities and private capital, operations in the construction industry can be stabilized to the greatest benefit of the construction industry, and hence to American economy. This is an end result of intense interest to every element in the industry, including the material producer.

Admittedly, achievement of this desirable result is difficult. However, once the goal is accepted as desirable and necessary, means of accomplishment may arise from widespread consideration of the problem.

I would like to suggest several avenues of approach to solution of the problem. First, the overall economic analysis by the new Council of Economic Advisers reporting to the President, could generally delineate the expected position of construction in the national economy for the period ahead. Its analysis is predicated on the advice of government officials, Federal, State and local, of the construction industry, and of business and labor.

This brings into play the judgments of practically all factors concerned with the authorization of construction in the period ahead. The analysis, furthermore, could differentiate between the prospective private and public construction demand. If there appeared to be a decline in prospective private construction, the necessary cause of action to be pursued by public authorities would be apparent.

While there would be no compulsion for public bodies to carry out these recommendations, public discussion and public opinion might bring about the desired action.

Furthermore, a joint Congressional committee has been created to consider the economic report and

propose Federal legislation, if needed. The Federal Works Agency could act as a medium to relate the anticipated cause of action with other Federal agencies, with State and local officials and with the construction industry.

Stabilization Requires Advance Planning

Whatever may be accomplished in such a program of stabilization from the utilization of public works, obviously it can be brought about only if needed public works are planned on a long-term basis and working drawings and specifications for individual projects also are prepared reasonably far in advance. Unquestionably there has been increasing recognition of this advance-planning requirement.

Fortunately, the States, towns, cities and counties are now at work preparing detailed plans for public works and acquiring sites. This planning program is being assisted by our Bureau of Community Facilities, which is making advances of Federal funds. The 65 million dollars so far appropriated by Congress for this purpose will suffice we believe, to plan about two billion, 100 million dollars worth of construction.

States and local communities, without Federal assistance, have completed plans for construction to cost around one billion, one hundred million. The present total potential reserve, therefore, is something like three billion, 200 million. The completed plans are being laid on the shelf for use as conditions permit or require.

Unfortunately, the shelf isn't large enough, and it is bound to suffer some attrition from time to time. It is our hope that provision will be made for replenishing the reserve from year to year, and that the planning program will gain acceptance as an established feature of State-Federal-local cooperation.

We feel that States and cities should be ready at all times to contribute their fair share to construction stability on short notice, which they will not be able to do unless they are prepared at all times with completed plans for needed and useful public projects.

If so prepared, it could reasonably be expected that public authorities would generally subscribe to the recommendations on timing of work developed by industry and government cooperatively—the kind of cooperation which we have seen and enjoyed in the operations of the Federal Works Agency.

Traffic on the Pennsylvania Turnpike

NATIONAL Safety Council statisticians have taken the pulse of one of the nation's most modern traffic arteries—the Pennsylvania Turnpike—and found the human element still the underlying factor in accidents, despite all the engineering skill and ingenuity devoted to this highway of tomorrow.

The special study, undertaken in cooperation with the Pennsylvania Turnpike Commission, used 1941 accident experience—the last year of so-called "normal" traffic . . .

The Turnpike has not eliminated all accidents and actually has increased the hazard of some types, the data revealed. Safety features built into the controlled access highway are somewhat balanced by the increased hazards growing out of driver inability to cope with the very speed which the highway permits . . .

The Turnpike had more accidents of certain types than the average rural highway. They were:

1. A large number of rear-end collisions—approximately one-fourth of all 1941 accidents—apparently resulted from the wide differences in speed on the Turnpike and driver misjudgment of distance. Passenger cars traveling at high speed frequently rammed or sideswiped the rears of slow-moving trucks or other vehicles in overtaking and passing, despite the presence of a passing lane.

2. Accidents in icy weather were almost four times more frequent than on other highways. The snowbelt location of the Turnpike and the higher speeds, plus high winds, numerous shady spots in the mountainous section—and lack of caution by the drivers themselves—undoubtedly contributed to such mishaps.

3. Far higher than the average in rural areas was the number of fixed object collisions on the Turnpike—with vehicles usually hitting the guard rail adjacent to the traffic lane. Such accidents accounted for 25 percent of the total.

Slightly more than half of all accidents occurred on tangents, an indication that the straightaways were hazardous when vehicles moving in the same direction operated over a wide range of speeds . . .

A cross-classification of accident types by highway elements reveals that 41 percent of the two-vehicle collisions involved a rear-end or side-swipe collision between vehicles moving in the same direction on a straight road, while only 10 percent of the total accidents of this type happened on curves.

—*Highway Research Abstracts, March, 1947.*

The Efficient Use of Limestone[1]

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MY REMARKS on this program are directed toward the use of agricultural lime. The need for it is great, consumption is increasing and production puts it in the class of big business. It is highly gratifying to know that not only the commercial or business aspects of the industry are to be given consideration at the convention but that the members are sincerely interested in the problems of the consumer on the land and of the agronomists who are more directly concerned with the research and educational programs relating to its use. The closest cooperation between producers, distributors and agronomists is essential at all times to maintain the business on a solid foundation.

There is no disagreement among agronomists, producers or distributors of liming materials on the use of lime as a basic principle in soil management. Dr. Emil Truog of Wisconsin who was responsible for the chapter on "Soil Acidity and Liming" in the 1938 U. S. D. A. Yearbook, "Soils and Men" stressed the value of liming when he stated—"Today liming of the land is accepted as a fundamental and necessary practice by all who are well informed in the matter. It is not too much to say that it must be the very backbone of profitable crop production, soil conservation and permanent agriculture in the humid regions of this country." He went on to point out, however, that there is need for improvement in chemical tests and methods for soil reaction, for further study of the functions and action of lime in soils and for more accurate measurement of the rate of loss of lime under varying conditions. I feel confident that Dr. Truog would list these as only a very few of the major problems needing study at this time. A check of the literature in recent years would appear to indicate that some of these fundamental studies have been side-tracked in favor of certain major and minor nutrient elements, the physical properties of soils, soil conservation, etc. It is the speaker's judgment that the importance of liming in relation to all other principles of a sound soil management program justifies continued and expanded research on these problems.

The fact that the Midwestern states use fully 75% of the total lime consumption in the United States is evidence of the fact that the region subscribes to a sweet land agriculture system rather than acid land agriculture. The advantages of the former far outweigh those of the latter. In evaluating these systems one must take into account the following considerations:

1. Calcium as a nutrient for plants as well as in relationship to animal nutrition.
2. The importance of adjusting the soil reaction to permit normal biological activity involving:
   a. Nitrification (decomposition of organic matter).
   b. Nitrogen-fixation (by bacteria).
   c. Availability of mineral nutrients.
3. The establishment of successful legume stands in the rotation is:
   a. Essential to an adequate conservation program.
   b. Essential to the production of high protein crops for feeding purposes.
   c. Essential in maintaining nitrogen and organic matter in soils.

On the basis of these considerations the only justifiable conclusion is limestone is fundamental for a permanent agriculture in the corn belt or any other humid region. Also we might be safe in stating that everyone is in agreement on all major points.

Now for a little while let us consider the matter of reconciling some differing viewpoints relative to the purposes of liming and measuring needs. As a preliminary to this brief discussion however first consider the situation in an acid soil.

1. There is a deficiency of calcium.

1 Presented at the 2nd Annual Convention, Agricultural Limestone Division, Edgewater Beach Hotel, Chicago, Ill., January 30-31, 1947.

2. There is a high concentration of exchangeable hydrogen which interferes with calcium absorption.
3. Increased hydrogen results in an increased intake of such elements as manganese, aluminum, zinc and iron.
4. There is a lower intake of phosphorus and potassium with increased acidity.
5. There is retarded biological activity.
6. There are effects on certain microorganisms especially fungi which may determine disease prevalence.

Fundamental Purposes of Liming

A. *Adjusting the soil reaction.*

In some states—notably Wisconsin—there has been a feeling that if the reaction was adjusted to a level of pH 6.5 conditions would be favorable for maximum biological activity and availability of soil nutrients. Here it would seem that the adjustment of the reaction to a certain level is the major consideration and if you do this everything else is taken care of.

B. *To supply available calcium.*

Some argue that acidity as such is not injurious and that hydrogen becomes directly toxic only at such low pH values as 3.0-3.5 and consequently the difficulty is due to lack of calcium. Therefore, the major value of liming is in supplying needed calcium.

C. *To counteract aluminum, manganese or other toxicity.*

Under certain conditions an increase in hydrogen results in an increased concentration of aluminum or some other element to the point of toxicity. This matter is being given major attention by investigators who are convinced that this is the most important reason for liming.

This is sufficient to indicate that although there may be some difference of opinion on the major objective of liming the fact remains that if lime is applied it will accomplish all three purposes, *i.e.,*—affect the reaction, furnish calcium and inhibit or prevent toxicity.

Measuring Limestone Needs

On this point there is a greater divergence of opinion and much work to be done.

A. *Exchangeable hydrogen or pH.* By these methods it is quite possible to determine the active and potential acidity of soils and determine the amount of pure lime or equivalent to completely neutralize the soil or adjust the reaction to a certain pH level. It takes 1,000 pounds of pure calcium carbonate to neutralize one milliequivalent of exchangeable hydrogen in the soil. In practice it is not necessary to bring the soil to absolute neutrality and therefore such measurements serve only as a guide in making recommendations under actual field conditions.

B. *Percent base saturation.* In recent years much attention has been given to the base exchange properties of soils. Research workers are accumulating great volumes of data on the exchangeable hydrogen, the exchange capacity, exchangeable bases and degree of base saturation in the profiles of many of the important soils of the country. Where correlations have been run it now appears that a 75-80 percent base saturation in soils is about optimum for maximum production of the major crops including legumes in this area. Some feel that such determination should be the basis for liming recommendations.

C. *Lime requirements, more particularly by quick tests such as the thiocyanate tests used in Illinois and Iowa.* This is an indirect measurement of the theoretical amount of pure lime or equivalent needed to grow alfalfa or sweet clover, regarded as the least acid tolerant or highest lime requirement crops grown in rotations. There may or may not be a close correlation of results by this method with pH measurements by other procedures. In general, this method has been quite satisfactory in the states where it has been used but there are some cases where it does not work so well. It is planned to do some further research in order to explain the reason for obtaining unsatisfactory results after lime applications are made.

Kinds of Liming Materials Available

Estimates of lime needs have been revised upward in practically all areas. In Iowa for example the needs total 60,000,000 tons to be applied over a ten year period. It is of considerable consequence therefore to consider the kinds, supply, availability, and quality of materials to meet this demand. Ground agricultural limestone, limestone screenings (from road rock, ballast or building materials) constitute the chief sources. Water purification sludges, beet sugar wastes, cement screenings, button dust and egg shells have been used where they are readily available and cheap.

Quality of Limestone Available

There is a very wide variation in the quality of limestone produced in the states.

A. *Formations in the State.* Part of the difference may be attributed to the particular geological formations which occur in any region. There is extreme variation in the neutralizing value of limestones from these formations ranging from 60-106%. The average for all producers in Iowa is 90.25%.

B. *Fineness of division.* This is the second major factor determining the efficiency of a liming material. There are no fixed grades or standards in many states in this region of highest consumption.

1. The A.A.A. set up a requirement for Iowa calling for 80% purity or C.C.E. and 90% passing an 8 mesh screen. A material would qualify for full payment when the per cent of purity of C.C.E. times the per cent passing an 8 mesh screen equalled or exceeded a factor of 72. The A.A.A. later specified that 25% should pass a 100 mesh screen but it had little meaning because the average limestone already exceeded this amount.

2. By a cooperative agreement between the Extension Service and the A.A.A. samples from all producing quarries in the state are submitted periodically to the central control laboratory at the college for tests. An average of 1200 samples shows for the state as a whole: 15.5% of the material is coarser than 8 mesh; 48% is 8 to 50 mesh in size; 11% is 50 to 100 mesh in size; and, 25.5% passes through a 100 mesh sieve.

3. From the standpoint of the producers it is assumed that they will put out a product which meets any specifications established by state or federal agencies, organizations or individuals as long as there is a demand and it can be marketed at a reasonable profit to the producer. Here is one area where the industry and the research worker in particular must work together more closely. The industry might say:

a. Coarse lime lasts longer and therefore is better to use.

b. As long as our product meets the specifications of A.A.A. or state agencies and the customer is satisfied—why change?

c. If we attempt to grind finer it will increase the cost of grinding so much that demand will fall off or the costs will be prohibitive.

d. If we grind finer it will slow up production and throw output and distribution out of adjustment —particularly during the peak periods.

The research worker on the other hand having in mind the variations in the formations in the area, the variations in soil types, the relative efficiency of different sized particles, crop responses, and the time factor in relation to the legume crops in the rotation may contend:

a. That coarse lime has little or no value.

b. That finer lime should cost little more to produce and the consumer should be willing to pay the small additional cost when he knows it pays.

c. It would be highly desirable to establish grades of limestone on some basis and work out a system of evaluating different products by using some factors.

These questions involving industry in the capacity of the producer, the research workers, the extension service, action agencies such as A.A.A. and S.C.S. and the consumer, are worthy of full and frank discussion. They cannot be answered today but are important enough to justify some conferences of representatives of all groups from time to time. Such a meeting has been held in Iowa in recent years and was very stimulating to say the least. The only suggestion is that they be held more often.

To this point in the discussion of the efficient use of limestone in agriculture we have considered some of the fundamental problems including:

1. Liming as a basic principle of management in a permanent agriculture.
2. The purposes of liming.
3. The question of measuring needs.
4. The types of materials available for use.
5. The basic factors governing the quality of a material, *i.e.*, neutralizing value, fineness.
6. Some of the problems of the producer.

There yet remains a consideration of some practical problems relating to the use of limestone which involve the consumer and the distributor and which have an important bearing on this question of efficiency in the use of limestone.

A. *The place in the rotation.* Lime is essentially a soil amendment and not a direct fertilizer for grain crops in rotation. Its primary value is in preparing the land for the successful and efficient growth of legume crops. There is a wide difference in the tolerance of legumes for acidity or the calcium requirement of such crops. Alfalfa and sweet clover on the one hand are high calcium requiring crops whereas lespedeza, crimson clover or even soybeans

may make a very satisfactory growth on soils which are quite acid. Yet all will agree that the yield, feeding value and contribution to the soil in the way of returning organic matter and fixed nitrogen will be materially enhanced by the addition of limestone.

B. *Rates of application.* In theory we say use lime in accordance with needs as revealed by soil tests. In practice we certainly do not get this much on. Especially during recent war years when production did not keep pace with demand and when A.A.A. practice allowances for individual farms were reduced, the tonnage available has been distributed on more acres at a lower rate. pH measurements of 4.0-4.5 or even 5.0 correspond in general with lime requirements of 3½-4 tons and yet 2-2½ tons per acre represents the average rate of application on most farms. Making up this deficit as well as reliming those areas where the benefits of previous applications have been exhausted indicate a continuing and expanded demand for agricultural lime in the future.

C. *Time of application.* Taking into consideration the facts that limestone is slowly soluble in soils, must go into solution to react with soil acids, and is essentially used to prepare the land for the efficient growth of legumes the one guiding principle is to apply the lime far enough ahead of the legume seedings to become effective. Six months to a year ahead would not be too much time to allow. And yet when one considers the peak production periods, road and field conditions and present methods of application it must be recognized that this principle cannot and will not be adhered to for the present at least. Far too much lime is being applied to small grain-legume seedings in the spring after the seedings have been made; to second and third year corn ground to be plowed under that year; to rotation pasture or hay land in the summer to be plowed under for 2-3 years of corn and beans before seeding to clover; or, to bean or corn ground in late fall or early winter after the crops have been harvested. On rolling land this often results in serious losses by erosion. As it now stands the distributor is the key to the situation. The trucker delivers the lime to the farm when he can get it and when your turn comes up and applies it on the land available or where he is willing to drive the truck.

Method of Application

The old days of shipping lime to the nearest railroad in open cars, shoveling it off into bottom boxes, hauling it several miles by team to the farm, hooking on a distributor and shoveling it again, are gone and farmers will not go back to them again. This is the day of heavy trucks with accessory loading and distributing equipment capable of high speed and spreading large volumes in a short period of time. Limestone consists of a mixture of coarse and fine particles and where trucks drive too fast and do not properly overlap in the field it results in uneven distribution of the lime, uneven legume stands and detracts from the efficiency of the practice.

All of these points which have been raised with respect to the application of limestone, directly or indirectly affect its efficient use. The producer, the distributor and the consumer must cooperate in solving these problems of mutual interest. If lime is applied to all the soils that need it for the efficient production of soil building legume crops, if it is applied at rates sufficiently high to do a good job, if it is applied long enough ahead of new seedings to react effectively, and if it is applied uniformly the value of the practice in agriculture will be materially enhanced and the industry will be assured of a continued and expanding demand.

It should be of concern to you as producers that this midwest area in particular, where consumption is greatest, continues to operate on a "sweet land" basis in which lime is such a fundamental factor in management. It is essential to keep in mind the basic purposes of liming and that improved methods of measuring soil reaction of limestone needs may well result in increasing demands for your product. Keep in mind that the industry is on a competitive basis as long as different materials are available for consumption and great differences exist in the geological formations within a given region as well as differences in the fineness of grinding. And last but not least you should not only be concerned with putting out a quality product but also with its use so that maximum efficiency is obtained by the consumer.

In my contacts with producers and distributors, I have found them most cooperative in considering problems of improving the quality of limestone made available to consumers and its use. Few if any management practices will yield such a high return on the investment as liming. Because liming is such a popular and well recognized practice in farming operations lime stands little chance of becoming a luxury commodity in farming operations. I can see nothing but a very bright future and a great need for expansion to keep pace with demand.

Some Basic Principles Concerning Use of Asphaltic Materials[1]

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THERE are numerous procedures for building asphalt surfaces in widespread use throughout the world. Sometimes they appear to be of conflicting character rather than different techniques to meet local conditions. It is felt therefore that a discussion of the over-all philosophy of using asphalt products in paving work may be both informative and of interest. If some of the statements which are made seem to be repetition, we trust that the audience will bear with us because from experience we have found that many of the younger men in the roadbuilding and paving industry are unfamiliar with the historical developments which have been the background for much of our modern practice.

First, it is to be remembered that asphalt is a cement—a binder—in fact, that is the meaning of the word, asphaltos being the Greek word meaning "not to split apart." Asphalt has been known for thousands of years, and its earliest use was as a cement to bind together some articles in household use. Shortly thereafter it was discovered that asphalt was waterproof, and accordingly it was employed for that purpose on dishes and reservoirs. It is reported that the basket in which the infant Moses was placed in the water was made waterproof by a coating of asphalt cement.

Second, asphalt is a petroleum product. Not all petroleums contain asphalt, but asphalt is a natural constituent of many petroleums widely distributed throughout the world. It was first discovered in the form of small pools in Mesopotamia, where the petroleum had seeped to the surface and, under nature's refining processes, the gasoline, kerosene and lighter oils had been evaporated leaving behind the asphalt cement. These seepages, pools and lakes are found in many places throughout the world, the most famous one being the Trinidad Lake on the Island by that name just off South America.

Asphalt is also found dispersed through sandstone and limestone. In this form it is known as rock asphalt. The earliest use of rock asphalt was not as a pavement but as a source of asphalt cement, the rock being mined, broken into small particles, then "cooked" in kettles to produce a mastic, used for cementing joints, roofing, etc. A number of these mines were operated in Europe, and it was noted that, where the broken particles had fallen from the carts hauling from the quarry to the place of refining, they became bonded together under traffic, forming a smooth and waterproof surface. This was the beginning of the modern asphalt pavement. Within a very short time thereafter the material was marketed throughout Europe and Great Britain for the purpose of putting down a deluxe form of street.

Rock asphalt was imported into the United States when this nation was young. At that time the United States was fundamentally a country of raw materials. Foreign traffic consisted of shipments of grain and other raw materials to Europe for processing. Many of these ships returned without cargo and therefore had to have ballast. Ballast was often supplied by loading with rock asphalt or with granite block. The familiar Belgium block is named after the granite block brought to this country from Belgium as ballast. One of the leading contracting firms in New York City is named the Sicilian Asphalt Paving Company from its origin as an importer of Sicilian rock asphalt and in the construction of pavements with this material.

With changing traffic conditions and with the development of the Trinidad Lake, it was but a step to the substitution of a mixture of asphalt and aggregate to produce a pavement. The first asphalt pavements had been the fine-textured rock asphalt; therefore, an attempt to duplicate them was likewise a natural procedure, and consequently sheet asphalt was one of the first types of asphalt pavement using the native sands mixed with the imported Trinidad asphalt.

1 Presented at the 30th Annual Convention, National Crushed Stone Association, Edgewater Beach Hotel, Chicago, Ill., January 27-29, 1947.

For a number of years asphalt construction was confined to cities. It was fairly expensive because of the hand labor involved in its construction. Its use was confined to the principal residential and shopping streets, where easy cleaning was an important consideration, and where the shock absorbing character of the asphalt surface made it desirable in contrast with the noisy cobblestones under

Asphalt penetration macadam base (foreground) with hot-mix asphaltic concrete surface (being spread) is often an economical as well as a very strong pavement for airport runways.

iron tires. The country roads, if improved at all, were either water-bound macadam or gravel. Traffic was entirely horse drawn and slow in movement, and the iron tires actually contributed to the improvement of the macadam surface.

As automobiles increased in number, however, this condition changed. The dust was pulled out of the macadam and gravel surfaces, and maintenance became increasingly expensive. With the increase in automobiles came increased consumption of gasoline and fortunately, parallel with this development, came the availability of asphalt residues from the refining of gasoline. It was but natural that these residues should be experimented with, first as a dust layer, and then as a more durable surface treatment. As some may recall, the standard method of maintenance of macadam streets was periodic sprinkling of water. One of the principal products of the Studebaker Company was a water sprinkler which was used by every town of any size in the country. These water sprinklers were adapted to the first application of residual asphaltic materials and were the forerunner of the modern asphalt distributor.

As it became more difficult to maintain a water-bound macadam surface, it was but another natural step to the substitution of asphalt cement as a binder in place of the rock dust. *This* was the beginning of the penetration macadam type of surface. At practically the same time experiments were made mixing coarser aggregates with asphalt in a mixing plant—a sort of mixed macadam, which we now generally term as asphaltic concrete. Most of these early developments took place along the sea coasts of the United States, because these areas were ones in which asphaltic residues were first available and also where there was the greatest demand for improved roads and streets.

With the increase in the number of motor vehicles, engineers in all states began to experiment with use of their local aggregates in combination with asphalt, and many new procedures were developed. Having experimented with and devised a satisfactory procedure, the engineer then wrote his own specification, based on his local experience. The only difficulty was that in the absence of a basic terminology the asphaltic materials employed were often described in such a manner as to be almost unintelligible to an engineer a few hundred miles away. This confusion finally became so great that in the early thirties, under the leadership of the Bureau of Public Roads and in cooperation with the Asphalt Institute and many states, a preliminary standardization of specifications was agreed upon covering liquid asphaltic products. These specifications have been revised from time to time in light of experience and are now in general use throughout the country.

The value of such cooperative work on the part of industry and the user is indicated by the phenomenal growth in utilization of these materials, being over 2,000,000 tons in 1946 as compared to 160,000 tons in 1930. Standardization is highly desirable with any group of products, provided it is not too rigid, and it is obvious that great economy can be secured where the minimum number of products are manufactured consistent with utility because of the lesser requirements for storage and separate manufacturing procedures. There is room for further standardization in certain grades of asphaltic products—particularly the slow-curing or residual asphalts. In general, the different grades are classified in such a manner that intelligent selection will obtain a material capable of meeting any situation. In the standardization of products during the 30's, the number of grades of cut-back asphalts was reduced from well over one hundred to about twelve.

It is probable that even fewer grades would meet present basic requirements for these materials.

Before proceeding with a discussion of the principles of the design of asphalt mixtures and selection of materials, a brief description of the present grades of asphaltic materials may be helpful. There are four general groups:

A. Asphalt Cements.

B. Slow-Curing Residual Asphalt Oils (Sometimes called Road Oil).

C. Cut-Back Asphalts.

D. Emulsified Asphalts.

A. Asphalt Cements

Asphalt cements are obtained by separating an asphaltic base petroleum into its various component parts in a refinery by distillation under applied heat and pressure. Many commercial asphaltic base petroleums are almost pure asphalt. The asphalt cement is recovered by driving off the gasoline, kerosene, fuel oil, etc., in a controlled manner so that a cement of any desired consistency may be obtained.

The principal means of measurement of these cements is with respect to hardness, designated as penetration. The penetration test determines the hardness of an asphalt cement by measuring the distance that a standard blunt pointed needle will vertically penetrate a sample of the material, under known conditions of temperature, loading and time. When other conditions are not specifically mentioned, it is understood that a penetration value or measurement implies that the material is tested at 77°F., that the needle is loaded with 100 grams and that the load is applied for 5 seconds. This is known as normal penetration. The unit of penetration is 1/10 millimeter, about 1/254 inch. It is, of course, evident that the softer the asphalt cement the greater will be its number of penetration units.

By means of penetration limits, asphalt cements are classified into grades on the basis of consistency. The Division of Simplified Practice of the National Bureau of Standards has established the following grades which have been widely adopted for the different classes of asphalt highway work.

B. Slow Curing Residual Asphaltic Oils

Residual or slow curing asphaltic materials are petroleum residues which have not been refined down to the hardness of an asphalt cement and which still contain a certain percentage of so-called "heavy ends" which are somewhat similar to lubricating oils. They were among the earliest products available for surface treatment and are extremely durable because of the heavy oil content. In some areas they are lower in cost than other products, and hence have found a wide use as dust layers and in secondary road surfacing. They are somewhat slow to "set" or develop binding qualities, except in the heavier grades, and for that reason have been supplanted in many instances with cut-back asphalts, emulsions, or soft asphalt cements which are made to more exact specifications.

Grades of Paving Asphalt
Normal Penetration Limits
(77°F., 100 g., 5 sec.)

25–30	50–60	85–100
30–40	60–70	100–120
40–50	70–85	120–150
		150–200

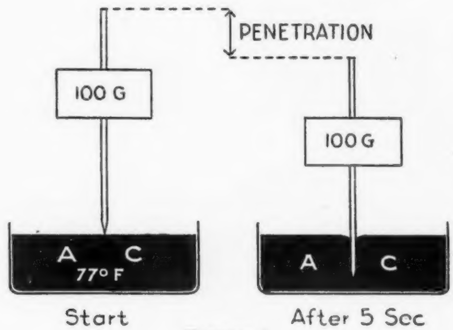

FIGURE 1.

C. Cut-Back Asphalts

Cut-back asphalts are manufactured by cutting back an asphalt cement with a definite percentage of liquifier or cutter stock, such as gasoline or kerosene. The procedure is exactly the same as thinning paint with turpentine, and the fluidity and rate of curing of a cut-back asphalt can be controlled by varying the percent and kind of cutter stock. Rapid curing cut-back asphalts are made by cutting asphalt cement with gasoline or naphtha. These materials are volatile and evaporate quickly from the blended mixture when spread in thin films so that only the asphalt cement remains. Medium curing cut-backs are asphalt cements that have been cut-back to a fluid condition with kerosene. Kerosene is a less volatile cutter stock than gasoline, and consequently such products cure at a slower rate than do those made with more volatile materials.

Two principal tests are used to evaluate these products, viscosity and distillation. The viscosity

test determines the fluidity of liquids and, in the case of liquid asphaltic products, is a measure of their resistance to flow. Determination of viscosity is made with a standard instrument known as the Furol Viscosimeter and results are expressed as Furol Viscosity. The test is made at any specified temperature by recording the time in seconds for 60 cubic centimeters of the product to flow through a tube of standard dimensions into a measuring flask. The longer the time required the higher is the viscosity of the asphaltic product and the closer is its approach to the consistency of a semi-solid.

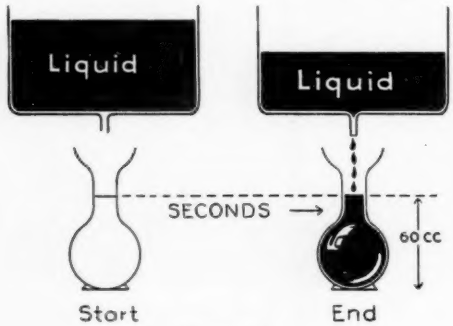

FIGURE 2.

While it would be highly desirable to express viscosity of all liquid asphaltic products at the normal temperature of 77°F., just as normal penetration of asphalt cements is expressed, no standard viscosimeter has been designed which can do this over the wide range of viscosities of the various liquid asphaltic road materials. The viscosity of an asphaltic product decreases as its temperature is raised and for those which are of higher viscosity at 77°F., than can be accurately measured by the viscosimeter, it becomes necessary to make the test at an elevated temperature. The temperatures most commonly used are 77°F., 122°F., 140°F., and 180°F.

The distillation test is applied to liquid asphaltic products, other than emulsions, to determine the amount and character of asphaltic residue which they may be expected to develop by volatilization of their lighter constituents under conditions of application and use, also the relative rapidity with which such residue will be developed.

The test is made by placing a measured volume of material in a distillation flask connected to a condenser and gradually heating it to a temperature of 680°F. Volatile products which are driven off are condensed and collected in a graduated receiver so that the volume per cent distilled at any desired intermediate temperature, as well as the end temperature, is readily indicated.

After distillation is completed the residue remaining in the flask is subjected to a consistency test and a test for solubility in carbon disulphide. If it is a semisolid and its penetration can be determined, it is also tested for ductility.

The distillation test in connection with a consistency test on the residue readily classifies the type of liquid asphaltic product under examination. If the residue is too soft for a penetration test the product may be classified as slow curing. If, however, the residue is sufficiently solid for a normal penetration test, the product is a cut-back asphalt. In such case if more than half of the total distillate comes over at a temperature of 437°F., the product may be classed as rapid curing while if considerably less than half of the total distillate comes over at this temperature, it should be classed as medium curing.

Six grades of each kind of cut-back asphalt have been standardized by the Federal Government, The Asphalt Institute, and the great majority of states. For convenience they are termed RC for rapid curing, MC for medium curing. An RC-0 grade is the

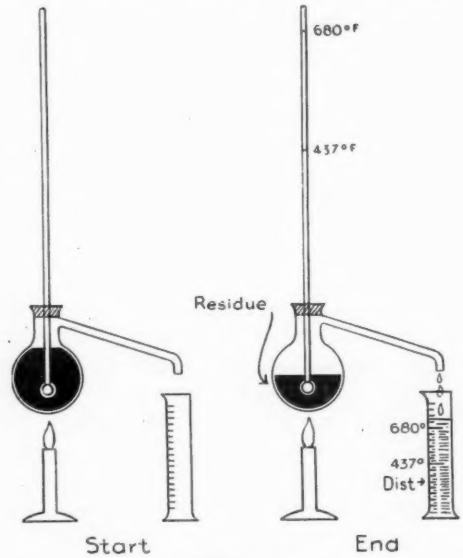

FIGURE 3.

one containing the smallest percentage of asphalt, and the RC-5 grade is the one containing the highest percentage of asphalt. The asphalt cement in each grade is the same, the only difference being the percentage of volatile material. The same relationship

applies to the medium curing grades. The particular grade which should be selected will depend upon the time element of manipulation so that, when the manipulation has been completed, only the asphalt cement is left. Obviously, if manipulation is rapid, then a much heavier product can be employed than when it is slow. Of course, time of manipulation is affected not only by equipment but also by climatic conditions, and by the character of the aggregate.

D. Emulsified Asphalts

Emulsified asphalts are ones where the asphalt cement is made fluid by mixing with water rather than with gasoline or kerosene. Such blends may be either asphalt in water (water phase emulsions) or water in asphalt (asphalt phase emulsions). The ones most commonly used in the United States are the water phase type. In order to produce such an emulsion, the asphalt cement is first heated, then run through a colloid mill where it is whipped into tiny globules. While in this finely divided state, it is mixed with water and maintained in a divided condition by the addition of an emulsifying agent, such as soap, clay, and certain alkali products. By varying the kind and amount of emulsifying agent, the rate of break or set of the asphalt globules into a solid mass or film may be controlled in respect to time. To meet a broad range of construction conditions, there have been developed three distinct varieties of emulsified asphalt—rapid setting, medium setting and slow setting. The Asphalt Institute Specifications include a total of six different grades. A selection from these products will meet any particular condition of use, such as surface treatment, plant mix, or mixture with finely divided soils.

Conditions of Usage

In considering the basic principles in the selection of a particular grade of asphalt and the design of a paving mixture, two factors must be kept in mind. First, as asphalt *cement* is the desired end result in practically every type of paving work. Second, the use of any liquid asphalt product is purely for convenience in the manipulation required to take care of a particular local condition. These conditions are in a constant state of change, and of paramount importance is the type of equipment that is or will be available. The development of new types of equipment to accomplish a particular type of work may completely alter the requirements for asphaltic materials. In general, consistent with manipulation limitations, the heaviest asphalt product should be employed. In other words, the shorter the manipulation period, the more rapid curing may be the asphaltic material.

Sometimes these changes in equipment lead to temporary reversals in the trend toward the heavier

Crushed stone road-mix surfaces are widely employed in areas where good aggregate supplies are available. The method lends itself to construction in half width thus avoiding detours.

products. For example, the early surface treatment work was largely accomplished with slow curing asphaltic materials of high viscosity. These materials were shipped in tank cars, and heating was accomplished by steam rollers and farm tractor engines, which then were readily available throughout the country. With the development of gasoline-driven rollers and farm tractors, these steam engines gradually disappeared, and it became increasingly difficult to heat these heavy asphaltic products at most places of use throughout the country. The practice, therefore, of using low-viscosity products which could be used cold became more and more the rule. The mixed-in-place types of construction (which were an outgrowth of surface treatment, resulting from experiments by engineers in dragging the aggregate cover to produce a smoother riding surface) came about in this same interval, and the asphaltic materials used as binders were likewise of low viscosity because operations had to be carried on in a slow manner with blade graders and harrows.

Today the trend toward heavier products has been resumed, due to the availability of the small portable steam boiler, designed specifically for tank-car

heating. However, these developments in equipment have not progressed at a uniform rate throughout this country or in other parts of the world. The volume of work being done in any particular area and the size of the individual job have a marked influence on the ability of either the public official to specify or the contractor to employ the most efficient equipment. It is but natural that procedures which may be economical in thickly-settled areas have been somewhat slower in adoption in the thinly-populated sections of the country. Accordingly, we find that the mixed-in-place procedure with blade graders and simple harrows is still a most desirable method in some areas, while in others the travel plant or the stationery plant has supplanted it almost entirely. In the first instance, it is still necessary to employ the more fluid asphaltic products to give the necessary time for manipulation, while in the latter the heavier asphaltic products are desirable.

Surface treated macadam makes up a large mileage not only of secondary roads but of the U. S. primary system as well. To do work rapidly it is common practice to accumulate large stock piles of crushed stone and then to load with mechanical equipment for quick transfer to the roadway.

This situation at times gives rise to confusion in specifying the correct grade of asphaltic materials and on several occasions has led the engineer to call for new grades or to modify requirements in present standard products. We realize fully that we shall be suspected of supporting some selfish motive on the part of the asphalt producer to retain only the present usual grades of material when we assert that such changes are seldom necessary. A single example, however, will show that this is not the case.

All through the Middle West a large mileage of highways has been constructed by the mixed-in-place method. The process involved repeated blading and harrowing to obtain a thorough mixing of the asphalt and aggregate, often requiring several days' time and in the event of bad weather a week or longer. During this period the asphaltic materials (containing a high percent of cutter stock or heavy oils) were gradually setting up as a result of volatilization or absorption into the fine particles of aggregate, yet the mixtures were pliable and could be spread in thin layers for final compaction.

When the travel plant began to be employed, so that in a single pass of the equipment the entire mixing was accomplished within a few minutes' time, the resultant mixture made with light asphaltic products contained such a high percent of the volatile material that it could not be immediately spread and compacted because curing had not been completed.

Instead of trying to change these light, slow curing products into more rapid curing ones by substituting more volatile gasoline for a part of the slower setting cutter stock, the logical procedure is to select an asphaltic material containing a much higher percentage of asphalt. In most cases, the substitution of the heavier 4 and 5 grades of cut-back asphalts and SC products in place of the lighter 2 and 3 grades will usually be the answer rather than trying to make new kinds of quick setting light products.

With the development of the modern portable asphalt mixing plant and the mechanical spreader, it is now often possible to place stationary plant mixtures at but little more cost than by the mixed-in-place method wherever the volume of work is of such amount as to absorb the overhead expense incidental to the plant investment. While the trend is in this direction, it will be desirable for some years to employ the mixed-in-place procedure in many areas, particularly for improved secondary roads. Thus, we shall continue to use blade graders, travel plants and stationary plants, and the asphalt industry will make available the various products which are required to meet these different construction conditions. The one fact to keep in mind is to select the particular asphalt product that fits the equipment and construction conditions, and that there are already available one or more asphaltic products which will accomplish the desired results.

Design of Asphaltic Concrete

Hot-mix asphaltic concrete (together with sheet asphalt) is considered to be the most durable and the most adaptable of all bituminous pavement types. Yet a number of fallacious notions prevail about it, and at times lead to unnecessary costs and

delays. Some of them lie in the carry-over from earlier days of certain requirements which were not always based upon sound analysis. For example, the first designs of sheet asphalt were predicated upon the experience of eastern cities such as New York and Philadelphia. It so happened that the sands available in these areas were of high natural stability, and it was thought that this quality was derived largely from gradation of the particles. Accordingly, specifications were written to the effect that an asphalt sand must have a certain gradation. As sheet asphalt was adopted by other cities, sands often were imported over long distances in order to comply with such specifications, whereas there were local aggregates available which would have been entirely satisfactory either in themselves or modified in only a slight degree by the addition of some other aggregate. The addition of a small percent of stone sands to unsatisfactory natural sands often will change them so that the resultant mixtures are entirely satisfactory.

This practice is increasing, and in many instances stone sands are being employed entirely as the fine aggregate. The point to be made is that, consistent with durability, local materials should be used to the fullest extent and that the criterion of suitability is not gradation alone but rather the quality of the end product. This, of course, requires testing of the final mixture and evaluating its qualities in comparison with service needs. Such tests have been devised, correlated with service behavior, and should be in general use. While gradation is a useful means of generally describing aggregates and mixtures, the utmost economy in design consistent with needed density and stability can be obtained only by appropriate laboratory studies, rather than by blind reliance on gradation alone. These laboratory studies will indicate not only the composition of the mixture which will best employ the aggregates available under ordinary conditions, but will serve to develop any needed special mixtures for extra duty conditions. Sometimes this will involve blending of aggregates to obtain the necessary qualities; often it will involve only an adjustment of the different proportions. For example, the ordinary street or airport runway does not require more than average stability mixtures to remain smooth under traffic, but the bus stop or the taxiway may require more strength. In the first instance a Hubbard-Field stability of 2500 may be more than adequate, whereas in the second case the values should be 4000 or more. These requirements may be measured by other standards, such as the triaxial shear test in a similar comparative manner.

It is quite possible to make asphaltic mixtures which will have both high tensile and compressive strength. Asphaltic concrete has been constructed having a tensile strength of several hundred pounds per square inch. This is seldom desirable for pavements because with high tensile strength there is usually brittleness, with consequent cracking of the surface under wide temperature changes. However, it is entirely practicable and desirable as a matter of routine design to make mixtures which, when compacted, will have definite load supporting power and without sacrifice of the desirable and necessary qualities of toughness and elasticity.

A study made last year on airport pavements[2] developed the not surprising fact that the asphaltic concrete surfaces placed upon some fifteen fields varied in stability to such a degree that measurements of the angle of stress distribution showed values varying from 0° to 58°. It often makes but little difference, so long as the pavement has the necessary minimum stability, but a little calculation will indicate just what it can mean in regard to further strengthening of an old pavement, or a new base. Take the contrast between two mixtures, one of low stability and a 0° distribution, and another having a high stability with stress distribution at 45°, each 3 inches thick. Assume a wheel load of 9,000 pounds, and a tire contact area of 90 square inches. In the first case, the unit load on the base will be practically the same as on the surface, or about 100 pounds. Under the high stability pavement, however, the area of base over which the load is spread will be approximately 220 square inches, or a unit load of about 40 pounds per square inch.

A recent survey of construction practices throughout the United States develops the surprising fact that few states or other design agencies attempt to design bituminous mixtures on any other basis than gradation or by general guessing. If the aggregates are naturally strong, they obtain stronger pavements than if the aggregates in use are inferior and have not been improved by modification of proportioning and addition of new aggregates. This undoubtedly accounts for the reported variation in behavior in different parts of the country, and the extraordinary thing is that so few pavements have given trouble from lack of stability. However, that is no excuse

[2] See L. A. Palmer report, Highway Research Board, December 1946.

for failure to develop the full potential values from the materials employed, or to adjust design to provide structural strength where required.

Another characteristic of asphaltic concrete which varies greatly is that of density. Density determines the degree of waterproofness of a pavement. It also has a marked influence on the wear resistance of a pavement. The influence of climate is exceedingly important with regard to the latter. A coarse-textured, open pavement which will be quite satisfactory in the south and west may wear very rapidly under the chain traffic and ice conditions of the north. It is, therefore, important that pavements placed in ice and snow areas should be quite dense, or at least placed in early summer so that further densification will take place under traffic.

Generally, mixtures containing small percentages of asphalt may have a higher stability than those containing large amounts. However, they may not be sufficiently dense to meet traffic requirements. In designing a mixture the minimum needed stability should be determined first, and then consistent with this stability, the largest possible amount of asphalt cement should be placed in the mixture because that is what makes it durable. Sometimes, however, the addition of more asphalt to a low-stability mixture will increase its stability. This is true of some sands as well as coarse aggregates, where normal percentages of asphalt may produce low stabilities. With some sands, when the asphalt is increased to as much as 14 percent, the mixture will have a stability equal to that required for the heaviest-traffic streets.

It cannot be too strongly stressed that each particular construction job requires a specific design in order to utilize available aggregates to maximum advantage. This design should be made with view to having definite standards of strength and density, and the inspection of the finished work should insure that these requirements are met.

The Asphalt Institute recently has published a Manual on Hot-Mix Asphaltic Concrete Paving in which these design procedures are clearly set forth, showing also how to select a specific job-mix formula and the corresponding paving plant formula. Five sizes of mixtures are shown, varying in gradation from 2″ maximum to ½″ maximum according to the thickness of pavement being placed. These gradations are described both by passing and retained and total passing methods, in each case giving the overall range of the different fractions.

These gradations are for a general guide only, the specific amount of each size of aggregate being determined by laboratory tests with reference to requirements for stability and density. Frequently it is possible to so vary these percentages that not only will the needed qualities be assured but the cost of the mixture may be lowered as a result of making maximum use of the lowest cost sizes. Sound laboratory exploration thus not only insures quality work but it often may save the contractor considerable money.

Summary

In this paper the authors have endeavored to point out a few of the salient features concerning the selection of asphaltic materials employed in surfacing work, as follows:

1. All asphalts are petroleum products, and have been developed to meet specific conditions of use.
2. The number of products, now standard, is usually sufficient to meet any and all construction and maintenance needs.
3. With the development of new equipment there is a trend toward use of heavier products, and these should be used instead of trying to make new quicker-curing light products.
4. In the design of asphaltic concrete more use should be made of laboratory studies to arrive at the proper proportioning of mixtures. Some duty conditions require different qualities of pavement than others, and reliance upon gradation alone will not, as a rule, give the best results. Furthermore, a lower cost mix may often result from laboratory studies.

Dr. Oliver Bowles Retires From Bureau of Mines

DR. OLIVER BOWLES after many years as Assistant Chief and Chief of the Nonmetal Economics Division of the U. S. Bureau of Mines retired effective January 31, 1947. Dr. Bowles had devoted thirty-three years to Federal Government service, during which time he had become known as an authority in the field of nonmetallic minerals.

While his many friends and acquaintances throughout the crushed stone industry will miss the contact with Dr. Bowles at the Bureau, the crushed stone industry extends to him every good wish for well earned happiness in the years ahead.

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Manufacturers of Farrel-Bacon Crushers and allied Screening & Conveying Equipment

Barber-Greene Company
Aurora, Illinois
Portable and Permanent Belt Conveyors, Belt Conveyor, Idlers, Bucket Loaders both Wheel and Crawler Mounted. Asphalt Mixers and Finishers, Coal Handling Machines

C. G. Buchanan Crushing Machinery Division of the Birdsboro Steel Foundry and Machine Co.
1941 Furnace St., Birdsboro, Pa.
Primary, Secondary and Finishing Crushers and Rolls

Bucyrus-Erie Co.
South Milwaukee, Wis.
Excavating, Drilling and Material Handling Equipment

Cross Engineering Co.
Carbondale, Pa.
Screen Plates and Sections, Perforated Plate, for Vibrating, Rotary and Shaking Screens

Deister Machine Company
1933 East Wayne Street, Fort Wayne, Ind.
Deister Plat-O Vibrating Screen, Deister Compound Funnel Classifier

Detroit Diesel Engine Division General Motors Corp.
13400 West Outer Drive, Detroit 23, Mich.
Light Weight, Compact 2 Cycle Diesel Engines and "Package Power" Units for All Classes of Service

Diamond Iron Works, Inc.
Minneapolis, Minn.
Rock Crushing, Conveying and Transmission Machinery

E. I. du Pont de Nemours & Co., Inc.
Wilmington, Del.
Explosives and Blasting Accessories

Easton Car and Construction Co.
Heavy-Duty Dump Body Trailers for Rock and Ore, Truck Bodies and Quarry Cars. Overhead Hoists for Dumping Haulage Units. Electric Heaters for Tar, Asphalt or Bitumen.

Ensign-Bickford Co.
Simsbury, Conn.
Cordeau-Bickford Detonating Fuse and Safety Fuse

Euclid Road Machinery Co.
1361 Chardon Road, Cleveland 17, Ohio
Heavy-Duty Trucks and Dump Trailers for "Off Highway" Hauls, Loaders for Earth Excavation

MANUFACTURERS' DIVISION of the NATIONAL CRUSHED STONE ASSOCIATION

Frog, Switch & Mfg. Co.
Carlisle, Pa.
Manganese Steel Department—Manufacturers of "Indian Brand" Manganese Steel Castings for Frogs, Switches and Crossings, Jaw and Gyratory Crushers, Cement Mill, Mining Machinery, etc., Steam Shovel Parts

General Electric Co.
1 River Road, Schenectady, N. Y.
Electric Motors

Goodyear Tire & Rubber Co.
Akron, Ohio
Belting (Conveyor, Elevator, Transmission), Hose (Air, Water, Steam, Suction, Miscellaneous), Chute Lining (Rubber).

Gruendler Crusher and Pulverizer Co.
2915 N. Market St., St. Louis, Mo.
Rock and Gravel Crushing and Screening Plants, Jaw Crushers, Roll Crushers, Hammer Mills, Lime Pulverizers

Harnischfeger Corp.
4400 W. National Ave., Milwaukee 14, Wis.
A complete line of Power Excavating Equipment, Overhead Cranes, Hoists, Smootharc Welders, Welding Rod, Motors and Generators

Hayward Co.
50 Church Street, New York City
Orange Peel Buckets, Clam Shell Buckets, Drag Line Buckets, Electric Motor Buckets, Automatic Take-up Reels

Heidenreich Eng. Co.
Newburgh, N. Y.

Hendrick Mfg. Co.
Carbondale, Pa.
Perforated Metal Screens, Perforated Plates for Vibrating, Shaking and Revolving Screens; Elevator Buckets; Hendrick Vibrating Screens

Hercules Powder Co.
Wilmington, Del.
Explosives and Blasting Supplies

Hetherington & Berner Inc.
701-745 Kentucky Ave., Indianapolis 7, Ind.
Asphalt Paving Machinery, Sand and Stone Dryers, Dust Collectors

Illinois Powder Mfg. Co.
124 N. 4th St., St. Louis, Mo.
Gold Medal Explosives

Iowa Manufacturing Co.
Cedar Rapids, Iowa
Rock and Gravel Crushing, Screening, Conveying and Washing Plants, Hot and Cold Mix Asphalt Plants, Stabilizer Plants, KU-BIT Impact Breakers, Screens, Elevators, Conveyors, Portable and Stationary Equipment.

Jeffrey Manufacturing Co.
E. First Ave., Columbus 16, Ohio
Material Handling Machinery, Crushers, Pulverizers, Screens, Chains

Kennedy-Van Saun Mfg. and Eng. Corp.
2 Park Ave., New York City
Material Handling Machinery—Crushers, Pulverizers, Vibrating Screens

Kensington Steel Co.
505 Kensington Ave., Chicago, Ill.
Manganese Steel Castings, Dipper Teeth, Crawler Treads, Jaw Plates, Concaves and Hammers

Keystone Driller Co.
Beaver Falls, Pa.
Drills, Power Shovels

The King Powder Co., Inc.
Cincinnati, Ohio
Detonite, Dynamites, and Blasting Supplies

Koehring Co.
3026 W. Concordia Ave., Milwaukee, Wis.
Mixers, Pavers, Shovels, Cranes, Draglines, Dumptors, Traildumps, Mud-Jacks

Lima Locomotive Works, Inc.
Shovel and Crane Division
1108 Lima Trust Bldg., Lima, Ohio
Power Shovels, Draglines and Cranes

Link-Belt Co.
300 West Pershing Road, Chicago, Ill.
Complete Stone Preparation Plants, Conveyors, Elevators, Screens, Washing Equipment, Speed-o-Matic Shovels—Cranes—Draglines and Power Transmission Equipment

Ludlow-Saylor Wire Co.
Newstead Ave. & Wabash R. R., St. Louis, Mo.
Woven Wire Screens and Wire Cloth of Super-Loy, Manga-Loy and all commercial alloys and metals

Mack Manufacturing Corp.
350 Fifth Ave., New York 1, N. Y.
Trucks, Truck-Tractors of All Types and Capacity, Gasoline or Diesel Power Optional

Maguire Industries, Incorporated
Nostrip Division
2010 Broadway, New York 23, N. Y.
Nostrip, Roctreet

Marion Power Shovel Co.
Marion, Ohio
A Complete Line of Power Shovels, Draglines and Cranes

McLanahan & Stone Corp.
Hollidaysburg, Pa.
Complete Pit, Mine and Quarry Equipment —Crushers, Washers, Screens, Feeders, etc.

MANUFACTURERS' DIVISION of the
NATIONAL CRUSHED STONE ASSOCIATION

New Holland Machine Co.
New Holland, Pa.
Limestone Pulverizers; Jaw, Roll, and Hammer Crushers; Elevators; Revolving and Vibrating Screens; Dewaterers; Belt and Apron Conveyors; Conveyor Belting; V-Belts; V-Belt Drives; Engines; Electric Motors; Concrete Mixers with or without Power Lifts

Noble Co.
1860 7th St., Oakland 7, Calif.
Batching Plants, Bulk Cement Plants

Nordberg Mfg. Co.
Milwaukee, Wis.
Cone, Gyratory, Jaw and Impact Crushers; Grinding Mills; Stone Plant and Cement Mill Machinery; Vibrating Screens; Grizzlies; Diesel and Steam Engines; Compressors; Mine Hoists; Track Maintenance Tools

Northern Blower Co.
65th St. South of Denison, Cleveland, Ohio
Dust Collecting Systems, Fans—Exhaust and Blowers

Northwest Engineering Co.
28 E. Jackson Blvd., Chicago, Ill.
Shovels, Cranes, Draglines, Pullshovels

Pioneer Engineering Works, Inc.
1515 Central Avenue, Minneapolis, Minn.
Jaw and Roll Crushers, Vibrating and Revolving Screens, Scrubbers, Belt Conveyors, Traveling Grizzley Feeder

Pit and Quarry Publications
538 South Clark St., Chicago, Ill.
Pit and Quarry, Pit and Quarry Handbook, Pit and Quarry Directory, Concrete Manufacturer, Concrete Industries Yearbook

Robins Conveyors Incorporated
270 Passaic Avenue, Passaic, N. J.
Belt Conveyors, Bucket Elevators, Gyrex and Vibrex Screens, Feeders, Design and Construction of Complete Plants

Rock Products
309 West Jackson Blvd., Chicago, Ill.

Sanderson-Cyclone Drill Company
South Main St., Orrville, Ohio
All Steel Wire Line, Air Speed Spudder, Large Blast Hole Drills, Drilling Tools and Drilling Supplies

Screen Equipment Co.
9 Lafayette Ave., Buffalo, N. Y.
SECO Vibrating Screens

Simplicity Engineering Co.
Durand, Mich.
Simplicity Gyrating Screen, Simplicity D'centegrator, Simplicity D'watering Wheel

Smith Engineering Works
E. Capitol Drive at N. Holton Ave., Milwaukee, Wis.
Gyratory, Gyrasphere, Jaw and Roll Crushers, Vibrating and Rotary Screens, Gravel Washing and Sand Settling Equipment, Elevators and Conveyors, Feeders, Bin Gates, and Portable Crushing and Screening Plants

St. Regis Paper Co.
2601 O'Sullivan Bldg., Baltimore 2, Md.
Main Office: 230 Park Ave., New York 17, N. Y.
Automatic Filling and Weighing Machines and Multiwall Paper Shipping Sacks

Stedman's Foundry & Machine Works
Aurora, Indiana
Stedman Impact-Type Selective Reduction Crushers, 2-Stage Swing Hammer Limestone Pulverizers

Stephens-Adamson Mfg. Co.
Aurora, Ill.
Belt Conveyors, Elevators, Feeders, Car Pullers, Screens, Skip Hoists, Complete Plants

Taggart Corp.
(See St. Regis Paper Co.)

Taylor-Wharton Iron & Steel Co.
High Bridge, N. J.
Manganese and other Special Alloy Steel Castings

The Thew Shovel Co.
Lorain, Ohio
Power Shovels, Cranes, Crawler Cranes, Locomotive Cranes, Draglines. Diesel Electric, Gasoline. 3/8 to 2-1/2 cu. yd. capacities

The Traylor Engineering & Mfg. Co.
Allentown, Pa.
Stone Crushing, Gravel, Lime and Cement Machinery

Trojan Powder Co.
17 N. 7th St., Allentown, Pa.
Explosives and Blasting Supplies

The W. S. Tyler Co.
3615 Superior Ave., N. E., Cleveland, Ohio
Wire Screens, Screening Machinery, Scrubbers, Testing Sieves and Dryers

Vibration Measurement Engineers
7721 Sheridan Rd., Chicago, Ill.

Technical Publications
of the
National Crushed Stone Association

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ENGINEERING BULLETINS

No. 1. The Bulking of Sand and Its Effect on Concrete

No. 2. Low Cost Improvement of Earth Roads with Crushed Stone

No. 3. The Water-Ratio Specification for Concrete and Its Limitations
(Supply Exhausted)

No. 4. "Retreading" Our Highways

No. 5. Reprint of "Comparative Tests of Crushed Stone and Gravel Concrete in New Jersey" with Discussion

No. 6. The Bituminous Macadam Pavement

No. 7. Investigations in the Proportioning of Concrete for Highways.

No. 8. The Effect of Transportation Methods and Costs on the Crushed Stone, Sand and Gravel, and Slag Industries
(Supply Exhausted)

No. 9. Tests for the Traffic Durability of Bituminous Pavements

No. 10. Stone Sand

No. 11. A Method for Proportioning Concrete for Compressive Strength, Durability and Workability

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STONE BRIEFS

No. 1. How to Proportion Workable Concrete for Any Desired Compressive Strength

No. 2. How to Proportion Concrete for Pavements

No. 3. Uses for Stone Screenings

No. 4. How to Determine the Required Thickness of the Non-Rigid Type of Pavement for Highways and Airport Runways

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Single copies of the above publications are available upon request.

Manual of Uniform Cost Accounting Principles and Procedure for the Crushed Stone Industry ($2.00 per copy)